INDUSTRIAL LEAD POISONING

with special reference to that found in the Potteries.

A Thesis

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by

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INDUSTRIAL LEAD POISONING.

The importance of Lead Poisoning from the Industrial aspect is very great on account of the number of cases which are notified and the number of deaths. Lead has a much wider application in the arts and manufactures than any other metal except Iron. The evil effects of lead poisoning are frequently widely spread through a community. Lead pipes are used to convey drinking water into dwelling houses, cisterns made of lead are used for storing water, tinned meat and fruits may become contaminated by the lead dissolved out of the solder, and there are in addition many industries in which lead in one form or another is used. Lead and its compounds, therefore, have many chances of producing their injurious influence on mankind. Lead exerts its effects in an insidious manner in the early stages, and it is essential that the effects are elucidated in this stage so that the individual may be withdrawn from work and given treatment. It has been remarked from time to time that persons may show an idiosyncrasy to the malign effects of lead, members of the same family may suffer from Plumbism, while their co-workers have escaped

although exposed to the influence of lead for longer periods. Sex has a very determining influence in the incidence of Plumbism. Females are much more susceptible to this poison than males. It is also seen that the younger the lead worker the more liable is he to contract lead poisoning.

Poisoning takes place in persons who inhale air contaminated by lead particles, who handle soluble lead salts, and who manipulate the metal itself.

All the systems of the body may be affected by Lead and when the Alimentary tract is primarily affected (e.g. Colic, Blue Line on Gums) the diagnosis of Plumbism is easy, but when the patient suffers from Chronic ill health, disease of internal organs, and nervous disturbance, the relationship to Lead poisoning may be overlooked.

Metallic Lead by itself does not cause many cases of Plumbism, hence the lead miner of Great Britain is practically immune, on account of the ore being nearly pure lead. A very different condition of affairs obtains at the Broken Hill Mines of Australia. The ore in this case contains lead in the form of lead carbonate and several cases of poisoning have occurred. In the industries of Red and White Lead, the largest numbers of cases of Plumbism are seen. In the manufacture of Red Lead the air becomes contaminated by lead

dust and fume and from this industry 1% - 2% of the total cases of Plumbism are notified to the Home Office. Very small quantities are absorbed into the system daily and particularly in this type of case, the insidious manner in which lead exerts its malign influence, is demonstrated. The same state of affairs exists in the White Lead Industry.

The Lead compounds are assisted in producing their deleterious effects on account of (1) The size of the ultimate particles and therefore the ease with which these particles are disseminated through the atmosphere (2) The solubility of these particles in the normal fluids of the body, viz. Saliva, Pharyngeal, Tracheal and Bronchial Mucus, gastric and Intestinal Secretions.

Next to the manufacture of Red and White Lead, the pottery industry gives the largest number of cases of Plumbism. It is estimated that 90% of the pottery in use is made in North Staffordshire in the area of the five towns, viz. Stoke-on-Trent, Fenton, Hanley, Burslem and Longton and collectively named "the potteries". During the last two years I have on several occasions been confronted by cases of Plumbism connected definitely with the lead occupation.

In 1896 the first Act of Parliament was passed which rendered Lead Poisoning a notifiable disease and from this

time, statistics are available. During recent years, Plumbism has come into greater prominence owing to the work and writings of Sir T. Oliver and also on account of the various inquiries held by Departmental Committees appointed by Parliament. The manufacture of White Lead and the use of lead in the China and Earthenware industry have each been the subject of a Departmental Committee's Report. Sir Edward Thorpe and Sir Thomas Oliver were appointed by the Home Secretary in 1898 to inquire into Lead Poisoning in the Potteries on account of there having been several deaths and much ill health due to Plumbism. Not only is the death rate high and numerous cases notified from the industries occupied in making lead compounds, but in those trades in which the lead compounds are used, e.g. painters, plumbers and glaziers, the same condition of affairs exists. I propose to include in this thesis the subject of Industrial Lead Poisoning generally, and deal in more detail with that seen locally in the manufacture of Pottery.

HISTORICAL OUTLINE.

The use of Lead for various industrial processes and for painting was well-known to the ancients. The pernicious effects of lead were equally well-known. Lead Colic was known in ancient times and was described by Pliny. Hippocrates was also acquainted with Lead Colic.

In the time of Caesar Augustus the use of lead pipes to conduct water was forbidden owing to the Cerusse which was formed being hurtful to the human body. Lead was very little used on the continent by the ancients. The reservoirs for holding water were made either of marble or of cement and the domestic utensils were made of pottery or of copper.

Aethius in the 16th century gave a description of a type of colic known as "Bellon" which was frequently a sequel to the drinking of certain wines. It was later discovered by Fronchin that these wines could dissolve the glaze from the earthenware vessels, the glaze being compounded with Litharge.

In the 17th century the definite co-relation between Lead Colic and the so-called "Metallic Colic" was properly understood, and the symptoms of colic which were seen in Lead miners and smelters were ascribed and directly traced to

poisoning by the metal and its compounds.

Galen in his "De Medicina" states that the water which is carried through leaden pipes becomes muddy and causes dysenteric symptoms in those who drank it.

During the 18th centruy Sir George Baker described the production of Colica Pictonum being due to the drinking of cider which had been contaminated with lead.

In 1788, John Hunter described "Dry Bellyache" which periodically affected the garrison of Jamaica, and demonstrated that this was due to the drinking of rum which was contaminated with lead.

CHEMISTRY.

Lead is bluish-grey in colour and when freshly cut presents the familiar metallic lustrous surface. After exposure to the air however, the surface becomes dull owing to the formation of a coating of Lead Oxide. It is a soft metal, easily marked by the finger nail and when drawn across paper a black mark is left.

The Atomic weight is 206·4, the density 11.85 and it melts at a temperature of 325° C. At this temperature some volatilization takes place, the vapour being re-precipitated

in the form of Lead Oxide. Lead Sulphide or Galena is the form in which lead is chiefly found in nature and from this compound the actual metal is produced. Lead is not acted on by pure water in the absence of air, but when air is present, Lead hydroxide is formed which is slightly soluble in water.

Water attacks lead more readily when it is in combination with another metal such as solder, copper, bronze or iron, the result being a Hydrated Oxide.

The maximum effect is produced with water slightly acid and with solutions of Chlorides and Nitrates while the presence of Bicarbonates or Carbonic Acid reduces the solubility to a great extent owing to the formation of Lead Carbonate which firmly adheres to the surface of the metal.

Lead is soluble in Nitric Acid but is sparingly soluble in Hydrochloric Acid and Sulphuric Acid.

The soluble salts of Lead, viz. Acetate and Nitrate are precipitated by Hydrogen Sulphide as a brown or black precipitate which is insoluble in Ammonium Sulphide. This sulphide is, however, appreciably soluble in the mineral acids. Soluble salts of Lead are precipitated by Albumin or Peptone, the precipitate however is very unstable.

Other Salts of the metal are:-

1. The Oxides of which those of greatest interest are

the Protoxides (Mascicot and Litharge), Protoxide Hydrate and Bioxide.

2. The Carbonate and Hydrated Carbonates which are used in a large number of industrial processes and which cause much lead poisoning.

3. The Acetates, basic and normal, which are concerned in the production of white lead - the process of converting metallic Lead into the hydrated carbonate through the medium of steam and acetic acid.

4. The Chromate which is used as a pigment.

5. The Nitrates and Chlorides, the latter is particularly used as an oxidising agent in Plumbing, Soldering and Tinning of metals.

6. The Silicates, Silico-borates and Silico-fluoborates which form many varieties of glass and crystals used in optical instruments and in the glazes and colours used in the Pottery industry.

"Fritted Lead" is the name given to a compound of Raw Lead (Carbonate), Silica, and Boric Acid fused together at a high temperature. This product is extremely hard and sparingly soluble in acids.

These compounds include the principal ones employed commercially and therefore give rise to the baneful effects. Some are much more prone to give rise to Plumbism than others on account of (a) greater use (b) solubility and (c) ease of aerial dissemination.

SYMPTOMATOLOGY.

All the industries which I have enumerated ~~above~~ LATER, are associated with Lead in one form or another. From statistics, it is seen that the number of cases of Plumbism has declined very much since the year 1900 but there has not been a corresponding decrease in the number of fatal cases. Since 1900, special regulations have come into force, and if anything is required to show what Preventive Medicine and Home Office regulations have accomplished in the direction of reducing the number of cases of Plumbism and removing much of the stigma attached to certain industries, e.g. White Lead Manufacture and China and Earthenware Industry, it is the record of notification of cases of Lead Poisoning and the deaths therefrom over a period of twenty years.

The following table I have taken from the Annual Report of the Chief Inspector of Factories for the year 1920:-

Year	1900	1901	1902	1903-5 average	1906-8 average	1909-11
Cases	1058	863	629	601	619	576
Deaths	38	34	14	23	30	35

Year	1912-14 average	1915-17	1918	1919	1920
Cases	522	349	144	207	243
Deaths	33	21	11	26	23

The percentage of deaths in 1900 was 3.2, whereas in 1920 it was 9.5, even although the total number of cases notified showed a very marked decrease.

Lead Poisoning may be subdivided into two types, viz. Acute and Chronic.

Acute Lead Poisoning.

This is extremely rare and industrially it hardly ever occurs. In most instances this is due to the swallowing of one or more large doses of a lead salt, either to commit suicide, as an abortifacient, or accidentally. The symptoms in this case are, the patient complains of an astringent metallic taste in the mouth, a burning pricking sensation in the throat and gullet. Pain in the stomach is also complained of and succeeded after an interval by nausea and vomiting, the vomited matter being streaked with blood. Diarrhea may supervene early. The fauces become extremely dry and there is great thirst. Colicky pains develop in the abdomen, the abdominal walls are tense and contracted, and the pains are relieved by pressure. Instead of looseness of the bowels there may be constipation. If the stools are passed , they are black in colour and have a very offensive odour. Should the case be prolonged, the patient complains of cramplike pains in the thighs and calves, and there is likely to be numbness and paralysis of the limbs. The

Respiratory and Pulse rates are decreased and there is a fall in the blood pressure. The skin becomes covered with a cold clammy perspiration. Coma or convulsions may precede death. The case, however, may pass on to one of Chronic Poisoning

No matter how Plumbism is induced, whether by inhalation of dust, cutaneous absorption or swallowing of soluble lead salts, the symptoms are the same. The continuous entrance of minute traces of lead into the body induces the most severe cases of Plumbism, rather than the entrance of one large dose.

Chronic Lead Poisoning.

In this type, the Lead acts slowly, insidiously and gradually but with certainty, and undermines health. This ingestion of minute traces may be taking place for 40 years as is case No. I, before the patient can be definitely diagnosed to be suffering from Plumbism.

The earliest symptoms of poisoning by lead are found in the Circulatory System. A curious pallor of the face is found in persons who have worked for a considerable time in a lead process. The estimation of Haemoglobin may be practically normal and the appearance of the conjunctiva may not show such a diminution of colour as would be expected from the appearance of the face. A person who has a highly coloured complexion, soon loses the colour when working in Lead if susceptible, the colour only remaining on the cheek bones as a hectic flush

The conjunctival vessels show diminution in colour and the sclerotics may be distinctly yellow. Following closely on the pallor of the face, a well marked diminution of the subcutaneous fat takes place. This tissue is lost in greater proportion than any other. The loss of the orbital fat combined with that of the Buccinator fat gives the face a very curious appearance. Two well marked folds are seen, one the ordinary naso-labial fold but more distinct, and the other at the anterior margin of the Masseter, These two folds with the loss of the orbital fat gives the face a very pinched appearance. The wasting precedes any other symptom, so that loss of weight in a Lead worker should be regarded with suspicion and it behoves one to examine carefully for other signs of Plumbism. In some workers, this loss of weight does not pass a certain point and they may be regarded as having established a certain degree of immunity. The combination of pallor and wasting is an important factor in incipient poisoning.

Anaemia with the presence punctate Basophilia and with diminution of Haemoglobin in a Lead Worker is definite evidence that Lead absorption has taken place and going on to Poisoning. Blood destruction is also taking place and the yellow appearance of the sclerotics is due to the pigmentation of that tissue by altered blood pigment. Such a worker may at

any time develop a sudden attack of Colic or Paresis.

Wasting of the Muscles soon makes its appearance quite apart from any nerve lesion.

Blue Line and Burtonian Line.

Next to pallor of the face and Anaemia, one of the earliest signs of Plumbism, is the presence of the Blue Line in the mouth. This line does not show that the patient is suffering from Lead Poisoning, but taken with other signs or symptoms, it is valuable and shows that there is Lead in the system.

A great amount of controversy has raged round the significance of the Blue Line as to whether its presence is a sign of Lead absorption or can be taken as definitely determining that the person is suffering from Plumbism.

Two kinds of Burtonian Lines are described:

1. A fine blue line situated around the margins of the gums and on the papillae between the teeth. This is more frequently seen in proximity to teeth which are coated with tartar, than beside those which are clean. Sometimes there is a dark bluish staining of the inside of the cheek in apposition to a filthy tooth. This line can be removed by the vigorous application of the tooth-brush and is said to be due to the decomposition of the Lead Salts, which have gained access to the mouth, by the Sulphuretted Hydrogen produced by the decomposition of the food particles which have accumulated round the teeth

2. The true Burtonian Line is an entirely different thing. The Lead in this case is below the mucous membrane and cannot be removed by the tooth-brush. The line in this case is not confined to the edge of the mucous membrane of the gum, but may be as much as a quarter of an inch in depth. The line is always associated with marked Pyorrhoea Alveolaris. The gums are soft, bleed easily, spongy-looking and pus exudes from the edges. Pyorrhoea Alveolaris may of itself give a bluish grey appearance to the gum edges. This line is more frequently present on the lower gum and if present on both, it is more pronounced on the lower. Considerable doubt exists as to the way in which the true blue line is produced. It is said to be due to direct absorption of Lead particles from the mouth into the tissues of the gums. The particles of lead dust becoming deposited on the ulcerated margins of the gums are attacked by the Phagocytes and are deposited in the gum margins and in the lymphatics. In microscopical sections, the particles of Black Sulphide of Lead are found in the Lymphatics, in and between the cells of the gums. This Blue Line is not seen when the mucous membrane is intact, or in cases where the teeth are kept clean or where the teeth are absent. The Blue Line of Burton may occasionally be observed in other regions of the body. The Intestine is sometimes found to be stained with a bluish black deposit of Lead Sulphide. In

cases described by Oliver, the ingestion of Lead Oxide caused staining of the intestine. Histological examination of the intestine in these cases demonstrates that the Lead particles are present in the Lymphoid tissue of the intestine and in the interior of the intestinal cells.

Occasionally in cases in which considerable quantities of Lead have been taken into the Gastro intestinal system, a blue ring is found surrounding the Anus.

Constipation.

This is a well-known sign of Lead Poisoning and is a frequent precurser of Colic. It is not an invariable rule however, as some cases of Colic are preceded by intermittent Diarrhoea. Lead Workers frequently suffer from muscular pains, and Lumbago associated with constipation in a Lead Worker should be regarded seriously, as it is frequently a warning of Colic. Constipation is a dangerous symptom. The bowel is one of the principal routes for the excretion of Lead. Constipation, therefore, prevents the elimination of Lead, more remains in the bowel and is absorbed into the tissues and may precipitate an attack of Colic.

The signs and symptoms described so far need not prevent a worker from continuing at his employment. They demonstrate that the patient, while he is not actually suffering from Lead Poisoning, is coming under the influence of

Lead and that it is causing definite changes in the tissues. He may state that he feels quite well. The onset of the next symptom however prevents the person from working, namely:

Lead Colic:

This is probably the commonest symptom and the one which brings Lead Workers to seek advice. For sometime previous to the onset of Colic, the worker may complain of a metallic taste in the mouth and loss of appetite. The Colic usually appears quite suddenly. The patient is found rolling about his bed or on the floor in extreme agony, the legs are flexed at the hips on to the abdominal wall. The face is anxious-looking and drawn, the eyes staring and the body is covered with a cold clammy perspiration. During the spasm, the abdomen is retracted, and twitching of the abdominal muscles may be seen. In some cases, relief is obtained by pressure on the abdomen. In other cases the patient cannot allow even the slightest touch on the abdominal wall. During the acute stage the patient has a desire to defecate but this usually results simply in straining and perhaps the passage of a little blood-stained mucus. The Colic undergoes marked exacerbations and remissions. Vomiting is often present, the vomited matter consisting of thick tenacious mucus in considerable amount. In the intervals between the acute pains, the patient complains of a feeling of weight in the abdomen.

During the acute spasms, the pulse rate becomes very much decreased, usually to about 50 per minute, the temperature becomes subnormal and the blood pressure markedly raised.

The pain is situated in the lower part of the abdomen or in the neighbourhood of the Umbilicus. The urine is scanty and high coloured. The patient is extremely ill during the attack of Colic, but it is seldom that death occurs in the first attack. Following on the Acute comes the Chronic Stage in which the patient complains of discomfort in the abdomen which may persist several weeks. A period of complete remission ensues, only to be followed by another attack.

The cause of this symptom has been the subject of much investigation and controversy.

Oliver in Lead Poisoning in 1914 states "I have found in animals who have died from Acute Lead Poisoning the intestinal canal irregularly contracted in places: over a length of two or three inches it would be so firmly contracted as to have its calibre completely obliterated, so that while the pain might be explained by this severe muscular spasm, it might also be the result of the upper portion of the intestine contracting and making an effort to propel its contents into the constricted portion below".

Laennec quoted by Tanquerel des Planches states there

is no appreciable alteration of the digestive tube.

Tanquerel des Planches does not himself support the view that colic was associated with spasm of the intestines. In the text he states:"Nous voyons que dans vingt cas on n'a trouvé dans le tube digestive aucune alteration ou seulement quelque traces de congestion."

Other theories are :-

1. That the colic is due to vasoconstriction taking place in the Splanchnic Area.

2. That it is due to irritation of the Sympathetic Nervous System, particularly of the Solar Plexus, and that the colic is a reflex due to irritation of the nerves of this area.

Legge and Goadby lay great stress on the presence of minute haemorrhages. They are of opinion that the colic is set up by contraction of blood vessels, and it is well known that vaso-dilator drugs e.g. Amyl Nitrate, Nitroglycerine or Chloroform will cut short an attack of Colic. In these experiments on cats they demonstrate histologically that minute haemorrhages occur in all tissues, but more especially in the tissues principally affected by lead, viz. Kidneys in Nephritis, Brain in Encephalopathy, the Nerves in Paralysis, and in the Liver, Spleen and Heart.

Headache.

Persistent headache is very frequently complained of

by persons suffering from Plumbism and it is usually present when there is very little doubt about the diagnosis. The patient when he complains of headache usually has had Colic and constipation and has a high blood pressure. The position of the headache varies; sometimes vertex, at times occipital and occasionally flitting in position. In one of my cases, the patient stated his headache was always at the Temporal region, persistent and of the dull aching type and at times more intense than others.

Giddiness is very frequently present. Persistent headache is an exceedingly grave feature. Very often cerebration becomes slow and in cases , fatal Encephalopathy ensues. On the other hand delirium may supervene, followed by mania, frothing at the mouth and unconsciousness. If the patient recovers he is entirely ignorant of what has happened.

Circulatory System.

The Pulse during an attack of Colic is markedly slow, varying between 40 and 50 per minute. In the early stages the presence of a small rapid pulse should be regarded as a suspicious sign. During Colic the blood pressure is raised and may be between 140 - 160 m.m.s. of Mercury. As Lead absorption is going on the blood pressure is gradually rising and becomes established even although the definite diagnosis

of Plumbism cannot be made. In many cases of Plumbism, it is impossible to completely exclude other causes of increase of blood pressure, viz. Alcohol particularly, sometimes Syphilis and Gout.

Only in the later stages are the Cardiac Sounds modified. There is usually some increase of Cardiac Dulness to the left, the apex impulse is felt further from the Sternum and about the sixth interspace. On account of the Anaemia present, Haemic murmurs are heard at the Pulmonic Area.

Blood.

Distinctive changes take place in the Blood. Pallor is a very early sign. Estimated by Gowers' Haemoglobinometer, I have always found the percentage of Haemoglobin diminished. In some cases the percentage of Haemoglobin was much higher than one would expect along with the extreme pallor shown by the patient. In patients whose blood showed diminution of the Haemoglobin, the scleroties were frequently yellowish, this being due to the staining of the Sclerotics by altered blood pigment. In some cases the skin has a tendency to an icterous tinge.

The evil effect of Lead leaves its imprint on the Red Blood Corpuscles. Some diminution in the number of the Erythrocytes takes place, but not to such an extent as the diminution of Haemoglobin. Punctate Basophilia is frequently

seen but this feature is not diagnostic of Plumbism as this phenomenon is frequently seen in any severe anaemia where haemolysis has taken place. Alteration in the size and shape of the Erythrocytes is also seen in the later stages. but normoblasts are very rare.

The Leucocytes do not show any change in their structure. In Acute Lead Poisoning increase in the number of White Blood Corpuscles is seen, the increase being due to the presence of an increased number of Lymphocytes. In Chronic Lead Poisoning, the Leucocyte-count may not show any difference from normal, but a differential count shows a definite percentage increase of Lymphocytes and decreased percentage of Polymorpho-neuclear leucocytes. The number of Leucocytes is usually very near the higher limit of normal variation.

Blood Vessels.

Many of the symptoms of Chronic Lead Poisoning are referable to lesions of the Blood vessels. Arterio-sclerosis is very common in those who have worked continuously for a number of years in a Lead Process. This may be elicited by palpation of the artery, by the high blood pressure, registered by the Sphygmomanometer, and by the tendency to Renal Disease and Cerebral Haemorrhage in Lead Workers.

The degenerative change is found either in the Intima or middle coat of the artery.

The Blood vessels become rigid and the lumen may be entirely secluded by Endarteritis Obliterans. Taking into consideration, the clinical data and the facts demonstrated by Legge and Goadby in their experiments on cats, - one cannot but think that these minute haemorrhages, some macroscopical in size are sufficient to account for the symptoms.

Nervous System.

Lead attacks both the Central and Peripheral portions of the nervous system.. A maniacal outburst or a severe headache may be the precursor of an attack of Saturnine Encephalopathy. The twitching may commence in one arm or leg and gradually spread until the whole body is involved and the patient becomes unconscious. Convulsions in a Lead Worker are of serious significance. Sometimes Saturnine Encephalopathy is preceded by symptoms suggestive of Hysteria, the patient laughing or crying without any apparent cause. The signs of Plumbism when affecting the Central Nervous System may quite easily be mistaken for a Cerebral Tumour, headache, vomiting, one sided convulsions and optic neuritis may all be present.

Saturnine Encephalopathy is the most serious form of Plumbism.

Peripheral Nervous System:

The commonest type of Paralysis is one affecting the extensor muscles of the hand. For a considerable time some diminution of the extensor power may be present before the actual onset of the paralysis. In some cases there are definite prodromal signs, lassitude, general debility, and particularly loss of weight. Cramp of the muscles which later are paralysed have been noted in some cases. Tremor is very often present. It is of the fine type and is increased by movement (intention tremor). In some cases the weakness clears up and no difference can be found in the strength of the two wrists.

For descriptive purposes, the various forms of paralysis are grouped, the grouping varying according to the function of the muscles and not to their anatomical distribution.

1. Antibrachial Type (Dejerine - Klumple)

In this type, the first muscle affected is the Extensor Communis Digitorum with dropping of the Middle and Ring fingers. Extension of the Index and little finger is still possible owing to the separate muscle of extension, viz. Extensor Indicis and Extensor Minimi Digiti. Later, however, these muscles become affected and the characteristic deformity is produced. The hand is in the semi-prone position and when hanging down is at right angles to the forearm, the fingers slightly fixed with the thumb towards the palm and

the hand deflected to the ulmar side.

2. Brachial Type (Duchenne Erb)

Sometimes only the Deltoid is affected, but more commonly the Deltoid, Biceps, Brachials Anticus and Supinator Longus are affected. The arm in this case hangs loosely by the side and the forearm is semipronated. The arm cannot be raised nor can the forearm be flexed on the upper arm. Extension is not affected as the triceps is never involved.

3. Aran Duchenne Type

The Thenar, Hypothenar, and Interossei muscles are affected in this type. This form may occur alone or in combination with the Antibrachial type. The Paralysis in this combination type is the commonest.

4. Peroneal Type.

This is the rarest form of paralysis and is nearly always associated with the Antibrachial Type. The Tibialis Anticus muscle usually escapes. The affected muscles are the Peroneal and the Extensors of the toes. The Patient walks on the outer side of the foot, has difficulty in mounting stairs and cannot stand on the toes. The toes are dragged on the ground in walking and the foot is swung round. The gait is unsteady. In some occupations, the form of paralysis is definite and most frequently in muscles which perform the most work or the result of the peculiar movements necessary.

In File Cutters, the left hand holds the chisel, and the paralysis is usually seen in the small muscles of this hand.

In Lead Rollers, there is a flattening of the muscles of the Thenar and Hypothenar Eminences, stress is thrown on this part of the hand in pushing the lead plate towards the rollers.

In painters, the Brachial type is commoner than in any other trade, due to their frequently raising the arms above the head.

It has frequently been stated that Lead exerts a selective action on nerves. This theory however does not hold the same prominent position as formerly, and now it is more generally accepted that the paralysis takes place in certain groups of muscles according to their functional action.

Generalized Paralysis.

When the onset is slow, the subject is usually one who has previously been affected with a limited form of paralysis. When the generalized form sets in, the patient lies om his back, is incapable of rising and sometimes even unable to eat. The intercostals, diaphragm and larynx may be affected and there is dyspnoea and aphonia.

Eye.

Lead may affect both the external ocular muscles and the optic nerve. The external rectus muscle is most frequently involved, causing diplopia. Nerve changes in the eye, however, are of common occurrence. Optic neuritis or neuro-retinitis with haemorrhages may occur. This may be of Central Origin or secondary to the Renal condition. Vision may be completely lost, it may be slowly regained but never completely. Dilatation of the pupils is very frequently seen, and is often associated with early anaemia. In advanced cases, the whole picture is one of Albuminuric Retinitis. Foster Moore quoting Jeaffreson states that there is considerable doubt as to whether or not Lead may cause Optic Neuritis direct. He thinks that the retina changes are secondary to the Vascular or Renal changes. It is unusual to find eye symptoms present without other undoubted evidence of chronic Plumbism being present. Oliver, however, does not hold this view.

Kidneys.

The Kidneys form one channel of excretion for Lead salts, but in many cases of undoubted Plumbism, no lead at all has been found in the Urine. Clinically, Kidney disease, unless Albumen be detected in the urine, is not a prominent

sympton in the course of chronic Lead poisoning. There is a variation of opinion as to the change which actually occurs in the Kidney. Oliver states that the Renal change is a parenchymatous degeneration due to the irritation of the Lead particles on the delicate cells of the Glomeruli and Tubules, causing cloudy swelling and the appearance of Albumen in the Urine. Others state that the Renal change is primarily a change in the blood vessels and histologically arterio-sclerotic changes are found in the Kidneys. In the Potteries, the majority of Lead workers take alcohol freely. They are of opinion the alcohol helps in the elimination of Lead, an opinion which is negatived by the experiments of Legge and Goadby who have demonstrated clearly that the addition of Alcohol precipitated an attack of Lead Poisoning. The presence of an Alcoholic History therefore interferes with the differential investigation between parenchymatous and interstitial nephritis.

Sexual Idiosyncrasy.

Women exhibit a greater susceptibility to the effects of Lead than men. The menstrual function is markedly deranged and the disturbance may be in various ways. In some there may be amenorrhoea, while in others there may be menorrhagia or dysmenorrhoea. Women who are the subjects of Lead absorption and who may not present signs or symptoms of

definite Plumbism, show when pregnant a very marked tendency to abort. Even though the child is born alive a very large proportion of them die soon after birth. The percentage of still births is as high as miscarriages are frequent. The abortifacient effect of Lead is well-known and has given rise to its use in the form of Diachylon to produce abortion. The Lead circulating in the maternal blood determines the abortion. The poison may cause abortion either by irritating and causing contraction of the unstriped muscle of the Uterus or by causing the formation of Placental haemorrhages. The effect of Lead on the Uterine functions seems only to exist so long as the intake of the poison continues. Cases are recorded where women after having had several abortions while employed in a lead process have ultimately gone through a normal pregnancy and have given birth to a healthy infant.

There is a disturbing factor, however, in estimating the relative susceptibility of the sexes. In the Potteries, for instance, the more dangerous processes, colour blowing and ware cleaning, are carried out by women.

The greater susceptibility of females to the malign effects of Lead has induced the Home Office to prohibit women from working in the more dangerous processes. In the manufacture of White Lead, women are not allowed to be employed in the white beds or stoves.

Up to the present time, there is no direct evidence to show that the detrimental effect of Lead is seen in the offspring of the male Lead workers or as a predisposing cause of infant mortality or premature birth.

Case I

G. C. male, age 52 years, worked as a Glost Placer for 40 years. He is married and there are two children alive aged 11 and 7 years. He states he was quite well until April 1921 when he complained of giddiness, headache - occipital and temporal - dimness of vision, palpitation, pains in the stomach and marked constipation.

He states he is a smoker but not to excess and he also states that he consumes beer during the weekends only, as it relieves his constipation. Previous to April 1921, he does not remember when he had to consult his Doctor and he has not had any serious illness. He denies Luetic disease.

Present Illness.

During April 1921 he had to consult his Doctor on account of giddiness, headache, pains in the stomach, constipation and dimness of vision.

The first symptom he complained of was constipation which he states had been gradually increasing for about 6 months but he took no notice of this as he was able to rectify

this by taking Salts and Beer. The amount of Salts he has to take now is very much greater than previously. His eyesight has been failing for some considerable time, about 6 years. During April 1921, the other complaints arose and he applied for advice.

Present State.

On entering the consulting room, he walked very slowly and used his outstretched hands as a guide and notwithstanding this precaution, he knocked against a chair. He was very short of breath. He had a very anxious expression and his face was very pale. His lips had a tendency to cyanosis. His Respiratory rate was 26 per minute and his Pulse rate 78 per minute. His conjunctivae were dirty yellow in colour and his pupils were markedly dilated.

Alimentary Tract. He states he has a sweetish taste in his mouth.

The teeth were in a very well preserved condition except that the Molars were covered with Tartar. The Incisors, Canines and Bicuspids were comparatively clear but there was a distinct degree of Pyorrhoea Alveolaris. There was a definite Blue Line on the Gums, more evident on the lower. There was no pigmentation of the Buccal Mucous Membrane. The tongue was covered with a yellowish fur.

On inspection of the abdomen, it was seen to be rather

sunken, the lower costal margin, anterior superior iliac spines and crests of the Ilia, were very prominent. He did not complain of any abdominal pain and there was no tenderness on palpation. Faecal accumulations were palpable in the left Iliac Fossa. The Spleen or Liver were not palpable.

Circulatory System.

He complains of breathlessness and palpitation even after slight exertion and if he attempts to turn quickly or rise quickly from a chair, he feels giddy. Walking up a slight incline will bring on palpitation.

Pulse.

This is regular in force and rhythm and of very high tension. The arterial wall is thickened and very palpable after obliteration of the Pulse. The Blood Pressure is 190 m.ms of Mercury.

Heart.

After resting for some time, the apex impulse was not visible nor was there any pulsation in the Epigastric Region, nor in the neck. On Palpation, the Apex impulse was felt in the 6th interspace in the Nipple Line. It was forcible and prolonged. No thrills were present. On percussion the heart (superficial) dulness, was found to be increased. The upper border was at the 3rd Rib, the right border at the left border of the Sternum and the left border was one-half inch outside the Nipple Line.

Auscultation

At the apex the Heart sounds were forcible but there were no adventitious sounds. At the Pulmonic Area, a definite Systolic murmur was audible and at the Aortic Area a Systolic murmur was heard, rough in character and conducted towards the Right Clavicle. The second sound at the Aortic Area was slapping in character. The sounds at the Tricuspid were clear.

Blood.

Red Blood Corpuscles	4,000,000 per cub. Millimetre
White Blood Corpuscles	6,000 " " "
Haemoglobin	48%

Blood films show very deficient staining of the Red Blood Corpuscles. No punctate Basophilia were seen. Anisocytosis, Poikylocytosis and Polychromatophilia were present.

Respiratory System.

Nothing abnormal was found on Physical Examination of the Lungs.

Urinary System.

The Kidneys were not palpable. The urine was clear, Acid in reaction and the Specific Gravity was 1015. The abnormal ingredient was Albumin in very small amount. Microscopically granular casts were seen.

Nervous System.

He walked very deliberately and slowly and used his outstretched arms as a guide. Rombergs' sign was negative. Sensation was unaffected.

Reflexes.

The Knee Jerks were markedly exaggerated. Ankle Clonus was absent and Babinski's sign was negative. He had perfect control over the Sphincters.

The muscles were below par. The Interossei, Thenar amd Hypothenar muscles were atrophied. The Extensor power at the wrist was weak. The muscles contracted to Faradic Stimulus but required a greater current for the Right Hand than for the Left Hand to produce the same contractions.

He states he has lost weight during the last few years but is not sure what his actual weight has been. At present he weighs 8st. $9\frac{1}{2}$ lbs.

Eye.

The pupils were markedly dilated and re-acted sluggishly to light.

There was no involvement of the external muscles of the eye. The sclerotics were of a markedly dirty yellow colour. He was able to distinguish between light and dark but he could not count the number of fingers shown, nor could

he distinguish between the open and shut hand.

Vision of Right Eye was $\frac{6}{Nil}$.

" " Left Eye " $\frac{6}{Nil}$.

Case II.

E. P. Female, age 48 years, employed as a Majolica Paintress for 16 years. Married, had 11 pregnancies. There are 2 children alive. 5 were born at full term and there were 4 premature births.

She was very emaciated and complained of violent frontal headache, dimness of vision, constipation, vomiting and "Lumbago".

The constipation had been present for more than 8 years and she had had to take aperients regularly. There was slight dyspnoea and marked oedema of the feet and legs. Until two months ago she stated she had comparatively good health. At this time however, the headache became violent and she was gradually losing her sight. Her friends stated that the day previous, she had a "fit" and that she had never suffered from "fits" previously.

Present State.

On interrogation, she was very slow in answering questions and soon became listless and disinclined to answer.

She was extremely pale. Pulse rate 80 per minute. Respiratory rate 38 per minute. Temperature 97.8° F.

Both pupils were equal and dilated.

Alimentary Tract.

The lips were extremely pale but there was no tendency to cyanosis. The teeth were absent from both Maxillae. The tongue was comparatively dry and covered with a brown fur. The abdomen was sunken. She did not complain of any pain (abdominal) and there was no tenderness on palpation. Auscultatory percussion of the Stomach did not reveal any enlargement. Neither the Liver nor Spleen were palpable.

Circulatory System.

The Pulse was 80 per minute, irregular both in force and in rhythm. The vessels were thickened and the superficial Temporal Artery was tortuous. The Blood Pressure was 180 m.ms of Hg.

Heart. In the dorsal position, the Apex impulse was not visible, nor was there any Epigastric pulsation. The Apex impulse was palpable in the 6th interspace in the Nipple Line and felt to be irregular. No thrills were palpable.

Percussion. Deep dulness. The upper border of the Heart was at the 3rd Rib. The Right border at the Mid-sternal line and the Left border just external to the Nipple Line.

Auscultation. At the Mitral Area, the Heart sounds were faint

and the first sound was followed by a soft blowing murmur which was conducted into the Axilla.

At the Pulmonic Area, a soft blowing systolic murmur was audible and the second sound was weak. The Cardiac Sounds at the Aortic and Tricuspea Areas were pure but faint. The irregularity of the Heart was audible.

Blood. Haemoglobin 50%

Red Blood Corpuscles 3,000,000 per cub.mm.

White Blood Corpuscles 6,000 " " "

Films. The Red Blood Corpuscles take the staining very poorly and appear like rings. There was marked Poikylocytosis but no punctuate Basophilia.

Respiratory System.

The Respiratory rate was 38 per minute and there was slight dyspnoea and the patient was propped up on a bed rest.

On palpation, vocal fremitus was not impaired at the Anterior aspect of the Thorax, nor posteriorly at the upper dorsal region. At both bases however vocal fremitus was absent.

On Percussion, there was no abnormality of resonance anteriorly. At both bases posteriorly the percussion note was dull.

Auscultation. The Vesicular breath sounds were replaced by coarse bubbling râles. At both bases no breath sounds were

audible. The Sputum was abundant and very frothy.

Urinary System.

The Kidneys were not palpable. The Urine was pale in colour, Specific Gravity 1020. Acid in reaction and contained Albumin.

Nervous System.

Muscular power was comparatively good considering the extreme illness of the patient. Sensation was not affected and the patient had perfect control over the Sphincters. Reflexes were not impaired and Babinski's sign was negative.

Eye.

The Conjunctivae were very pale, and the Sclerotics were yellowish in colour.

The pupils were dilated and equal and they reacted very sluggishly to a bright light. There was no involvement of the external orbital muscles.

By Ophthalmoscopic examination, the Fundus showed definite evidence of chronic Albuminuric Retinitis.

This patient died ten days later and a Post Mortem examination was ordered by the Coroner.

External Examination.

The body was that of a female in a very emaciated condition. It was stiff from Rigor Mortis.

Internal Examination.

Lungs. There was a considerable quantity of free fluid in

the Pleural Sacs. There were no adhesions between the two layers of Pleura. On section of the Lungs, frothy fluid exuded.

Heart.

There was a small quantity of free fluid in the Pericardium but no evidence of Pericarditis. The Heart weighed 18 ozs. There was no evidence of excessive fattiness of the Heart.

The Left Ventricle was markedly hypertrophied and the muscle was pale. The Cusps of the Mitral Valve were thickened and nodular. The muscle of the Right Ventricle was thin and flabby. All the Semilunar Linear Valves appeared to be healthy.

Arteries.-

These vessels had thick walls and remained patent after section. There was no evidence of Atheroma of the Aorta ~~Atheromar~~.

Kidneys.

These organs were very easily removed. The perinephric fat was very much diminished.

Left Kidney

This organ was small and weighed $1\frac{3}{4}$ ozs. There were several small cysts on the surface. I cut into the Kidney along the convex border. The Capsule was thickened and difficult to remove. After tearing away the capsule, the surface of the cortex was very shaggy. The cortex was very

much reduced in size.

Right Kidney.

This organ was also small and weighed 2¼ ozs. In other respects it was similar to the Left Kidney.

Stomach.

The mucous membrane was injected and covered with mucus.

Intestines.

Small Intestine; no gross abnormality was evident.

Large Intestine; The calibre of the descending was diminished. There was injection of the mucous membrane of the Ascending Colon and the Caecum.

The Omentum was reduced in size.

Brain.

The surface was pale and the convolutions were flattened. There was no evidence of Cerebral Haemorrhage.

In the course of the evidence at the Inquest, the Coroner was informed that this woman had been permanently suspended from working in a Lead Process during 1912 and granted compensation. In 1917 she returned to work as a Dipper in a different factory where she signed a statement that she had never previously been employed in a Lead Process. This factory used a glaze of Low Solubility and hence the workers are free from Medical Inspection.

Case III.

W.L. male age 43 years.

This man had been a Glost Placer for 28 years. He had very good health previously and never had to consult his Doctor.

When I first saw him, he was unconscious. There was marked twitching of the muscles of the face, arms and legs. There was no oedema of the limbs.

Both pupils were contracted.

Breathing was stertorous.

He was under observation for 24 hours and during this time he did not pass any urine. He was catherized and only ¾ 4 of urine were withdrawn.

Pulse.

The pulse rate was 120 per minute, regular in force and rhythm and of very high tension. Blood pressure was 230 m.ms of Hg.

Heart.

Inspection:- The apex impulse was visible and there was pulsation in the Epigastrium and in the neck.

Palpation:- The apex impulse was palpable in the 6th Left interspace, just external to the Nipple Line. A slight thrill was palpable.

Percussion:- The upper border of Cardiac dulness was at the 3rd Rib, right border, at the mid sternal line, and

the left border, one inch external to the nipple line.

Auscultation:- At the Mitral Area, a double murmur was audible and the Cardiac Sounds were audible and faint but the first was partly replaced by a murmur.

The second sound at the Aortic Area was accentuated and there was a soft blowing systolic murmur at the Pulmonic Area.

Blood.

Red Blood Corpuscles 1,900,000 per cub. mm.

White Blood Corpuscles 6,200 " " "

Haemoglobin - 20%

Blood films show Poikylocytosis and Polychromatophilia.

Respiratory System.

Coarse bubblings râles were audible all over the chest.

Alimentary Tract.

The lips were pale. There was definite Pyorrhoea Alveolaris, but no evidence of a Burtonian Line. Liver was enlarged, the lower edge being palpable one inch below the costal margin.

Urine.

Reaction Acid, Abnormal ingredient Albumin .

Post Mortem:-

The body was that of a man moderately well nourished and stiff from Rigor Mortis.

Lungs.

There was a small quantity of free fluid in the Pleural

Cavity. There were no Pleural Adhesions. On section, the Lungs exuded a frothy serum.

Heart.

The Heart was considerably enlarged and weighed 22 ozs. There was no disease of any of the cusps of the valves, There was no atheromatous change in the Aorta. The other blood vessels were rigid and remained patent after section.

Left Kidney.

The perinephric fat had practically disappeared. The Kidney weighed 3 ozs. The Capsule was thickened and adherent and left a granular surface after stripping.

The Cortex was very much reduced in thickness.

Right Kidney:- Weight 3½ ozs. In other respects it was the same as the Left Kidney.

Brain.

The membranes were injected and the surface of the Brain was pale.

Case IV.

F.R.R. Male. Age 44 Years. Married. Glost Placer.

He had been a Glost Placer for 33 Years.

Previous History.

Until January 1921, he does not remember when he was off work. In January 1921, he had an attack of Influenza and was absent from his work for two weeks. He had always

had a good appetite, no trouble with his bowels, no headache and generally felt in very good form.

He has been a Total Abstainer all his life. He smokes cigarettes, but does not smoke or chew Tobacco.

He had to commence work at 7 a.m. and previous to commencing work he had a cup of Tea or Oxo and some Bread and Butter. He had his breakfast at the works at 9 a.m. and always relished his food. He has lost weight. Several years ago he was 12 stone and now he is 9 st. ½ lb.

Present illness.

On Sept. 23rd 1921, while he was at work he states he felt his legs going from under him and a queer sensation in his head as if something had cracked inside. He was unable to continue his work, felt very weak and had to be assisted home by two of his fellow workers. When I saw him, he complained of generalised weakness, more particularly of the Right Arm and Right Leg. He could speak, but his speech was slow and deliberate and at times indistinct. He complained of slight headache (temporal).

He also complained of dimness of vision, but this had beenprogressive since January 1921, when he had the attack of "Influenza". He perspires very easily.

Present Condition:-

Circulatory System.

The Pulse rate was 88 per minute. The Pulse was

regular in force and in rhythm and of high tension. The Radial Artery could be rolled under the finger and felt thickened. The Blood Pressure was 170 m.ms of Hg.

Heart.

Inspection in the Dorsal Position did not reveal any abnormality.

Palpation. Apex impulse was palpable in the 5th interspace in the Nipple Line.

Percussion. Upper border 3rd Rib.
Right border at left border of Sternum
Left border in the Nipple Line.

Auscultation. The Cardiac Sounds were pure, but the 2nd Aortic sound was accentuated.

Blood.

Red Blood Corpuscles - 4,000, 000
White " " - 8,000
Haemoglobin - 50%

Films:- R.B.C. take the stain very poorly. Anisocytosis, Poikylocytosis and Polychromatophilia were present.

Respiratory System.

Respiratory rate was 24 per minute. There was nothing abnormal found on Physical Examination.

Alimentary Tract:-

The tongue was moist and covered with a yellow fur. The Teeth were in very good condition, but there was slight

degree of Pyorrhoea Alveolaris.

There was a definite Blue Line on the lower gum, but no Pigmentation of the Buccal Mucous Membrane.

There was no complaint of pain or tenderness in the Abdomen. The Abdomen was rather sunken but not to such a degree as in Case I.

He has no trouble with his bowels.

Kidneys.

These organs were not palpable. Urine was cloudy. Specific Gravity 1022, Acid in reaction and contained Albumin. Microscopically Cellular casts were seen.

Nervous System.

He was unable to stand.

Sensation was unaffected.

The knee jerk on the Right side was markedly exaggerated, Ankle Clonus could be elicited and Babinski's sign was positive.

Triceps reflex on the Right side was also easily elicited.

He had perfect control over the sphincters.

The tongue on protrusion was deviated towards the paralysed side.

The pupils were equal, dilated and reacted sluggishly to light. There was no external Ocular Paralysis.

Examination of the eyes show.

V.R. $\frac{6}{24}$

V.L. $\frac{6}{36}$.

On October 13th his weight was 9 st. ½ lb.

Subsequent examination:-

November 10th 1921. Weight had increased to 9 st. 11 lb. He was able to walk with assistance. He dragged his Right Leg. The grip of the Right Hand was poor.

Urine Examination. Colour Amber; Specific Gravity 1020, Alkaline in Reaction and contained a trace of Albumin.

Case V.

A.B. age 48 years. Male. Glost Placer. There are 3 children, all of whom are healthy. His wife had no miscarriage.

Past History:-

He had been a Lead Worker for 31 years, the first two years he was an apprentice and has been a Glost Placer for 29 years. He has always had very good health. He commenced work at 7 a.m. and always had a light meal before commencing work, and had his breakfast at 9 a.m. at the works. His appetite has always been good. He takes Ale frequently and smokes, neither of which he admits doing to excess.

Present Illness:-

About the beginning of October 1921, he ceased to work of his own accord, owing to pains in the Left side of his chest and Palpitation which caused him a good deal of worry. He did not complain of anything else but on interrogation he admits having had Headaches (frontal), but did not attach any importance to them. He occasionally had indigestion but he has no trouble with his bowels. He has lost weight considerably. His present weight is 7 st. 12 lbs.

He is pale but has not the typical Saturnine Pallor.

Circulatory System:-

The pulse rate is 80 per minute, regular in force and rhythm and of very high tension. Blood Pressure is 230 m.ms of Hg.

Heart.-

In the Dorsal Position nothing abnormal seen.

Palpation. The Apex impulse is felt in the 5th interspace in the Nipple Line.

Percussion. Upper Border 3rd rib.

Right Border Mid Sternal Line.

Left Border ½ inch outside the Nipple Line

Auscultation, does not reveal any abnormality except that the 2nd Aortic sound is markedly accentuated.

Blood.

Red Blood Corpuscles 4,000,000

White Blood Corpuscles 9,000

Haemoglobin 35%

Films: Anisocytosis.

Respiratory System.-

Respiratory rate 24 per minute. No abnormality was found in this system.

Alimentary Tract.

The Lips were pale. The Teeth were in a very decayed condition and there was marked Pyorrhoea Alveolaris. There was a diffuse blueness of the gums, but no definite Blue Line. The tongue was covered with a brownish fur. The Abdomen was sunken but he didnot complain of any Colic or Constipation.

Kidneys:-

These organs were not palpable. He had no disturbance with Micturition.

Urine Examination:- Urine cloudy, Specific Gravity 1010, Acid in reaction and contained Albumin.

Microscopically cellular casts were present in the deposit.

Nervous System.

He could walk well, but walking up a hill or slight exertion caused pain at the Cardiac Region and Palpitation.

Sensation was unaffected and he has perfect control over the Sphincters.

The knee Jerks were very active but there was no Ankle Clonus and Babinski's sign was negative.

There was distinct flattening of the Thenar and Hypothenar Eminences. The Extensor power at the Wrists was very good.

Eyes.

He had noticed that his eyesight had been failing for some time, probably about 6 months.

V.R. - $\frac{6}{18}$

V.L. - $\frac{6}{18}$.

The discs were pale.

The pupils were equal, reacted to light and accommodation

The Sclerotics were yellowish.

Case VI.

N.B. Female. Age 45 years. Widow. Ware Cleaner and Dipper.

She has been employed in a Lead Process for 19 years.

Previous History.

In 1916, she suffered from Gastritis, and was advised to have all her teeth extracted on account of the Septic condition of her gums.

In January 1919, she had Influenza during the Epidemic. In August 1919, she had Hysterectomy performed on account of

Menorrhagia, which had been persistent for about two months.

Apart from above she had no previous illnesses. She has one daughter who is very healthy. She has not had any miscarriages or still births.

Present illness.

March 1922. During the past six weeks, she has been troubled with vomiting. At first she vomited about twice each week, but gradually the vomiting increased until practically every day. The vomiting comes on at any time, sometimes the vomitus is greenish, sometimes yellowish and usually slimy.

Headaches came on about the same time and the vomiting did not relieve the headache. The pain commenced in the Occipital Region passed over the Vertex to the Frontal region. She had also attacks of pain in the Abdomen, at the Epigastrium and Umbilicus, which was relieved very much by pressure and massage which she performed herself. She has not had any other trouble with her bowels. Her appetite had been very good until two months ago. Now she seldom takes any breakfast, but is ready for her mid-day meal.

Headaches became much worse about February 1922. There is marked pallor of the face and the conjunctiva is pale She does not think she has lost very much weight.

Circulatory System:-

Pulse:- 76 per minute, regular in force and rhythm and of high tension.

Blood pressure. 190 m.ms of Hg.

Heart.

Inspection and Palpation did not reveal any abnormalities.

Percussion. Upper border 3rd Rib.

Right " Left Sternal line

Left " Nipple Line.

Auscultation. All Cardiac Sounds were pure except the 2nd Aortic which was accentuated.

Blood.

Red Blood Corpuscles - 4,000,000

White " " - 5,000

Haemoglobin - 50%

Films show Anisocytosis, Polychromatophilia and Punctate Basophilia.

Respiratory System:-

Respiratory rate 18 per minute, no abnormalities were found.

Alimentary Tract:-

The lips were very pale. The gums were very healthy. All teeth were artificial. The tongue was moist and clean.

The Abdomen was sunken. She did not complain of any tenderness or palpation.

The Descending Colon did not contain any Scabylous masses.

Kidneys:

These were not palpable.

Urine was cloudy, Specific Gravity 1016. Acid in reaction and contained Albumin. Deposit Urates.

Nervous System.

No abnormalities were found in the Peripheral Nervous System.

Eyes.

Her eyesight had been gradually failing for about one year. The Pupils were dilated, equal, and reacted sluggishly to light.

V.L. - $\frac{6}{60}$.

V.R. - $\frac{6}{36}$.

Haemorrhages were present in both Fundi. The Sclerotics were yellowish.

THE INDUSTRIES IN WHICH LEAD POISONING OCCURS.

I propose to tabulate the principal industries in which Lead Poisoning occurs and utilise for this purpose the statistics given in the Annual Report of the Chief Inspector of Factories for the year 1920.

	Industry	Cases Notified.	Deaths.
1.	Smelting of Metals	45	3
2.	Printing	9	-
3.	File Cutting	3	1
4.	White Lead	17	-
5.	Red Lead	11	-
6.	China and Earthenware	24	13
7.	Litho-Transfers.	1	-
8.	Electric Accumulators	47	2
9.	Paint and Colours	9	-
10.	Coach Building	13	-
11.	Other Industries	179	4

Total number of cases of Lead Poisoning notified in the year 1920 = 243.

Total number of deaths from Lead Poisoning in the same year = 23.

At the beginning of the century, the manufacture of White Lead was responsible for the greatest number of cases of Plumbism from one industry.

The China and Earthenware Industry while responsible for fewer cases, had a greater number of deaths. In 1900, 358 cases were notified with 6 deaths from the White Lead Industry whereas the China and Earthenware Industry had 200 cases of Plumbism with 8 fatal cases.

In 1920, this unenviable position has been taken by the Electric Accumulators Industry, closely followed by the industry of Smelting of Metals. In the China and Earthenware Industry, however, whilst the number of cases notified has decreased considerably, the percentage of fatal cases has increased to a very marked extent.

I shall now briefly describe the processes in some of the principal industries and demonstrate how the workers are exposed to the influence of Lead.

a. Lead Mining:-

The Lead miner of Britain does not suffer from Lead poisoning due to the fact that the Lead is found in almost pure metallic state. In the Broken Hill Mines of Australia, however, Lead Carbonate is the form in which the mineral is found and several miners have died from Saturnine Encephalopathy

the Cerebral type of Plumbism. The industry in Britain has declined very much and is now confined to Derbyshire, the North of England and the Lowlands of Scotland.

b. Smelting of Metals.

With the smelting of the Lead ore, the danger to health and life commences. The danger arises from the fumes given off from the molten metal in the furnaces reaching the workmen and so the furnacemen run considerable risk. The smoke and fume given off from the furnace are carried into the flues which may be as much as a mile in length and at the end of each flue is a chimney stack usually 100 to 150 feet high. The major portion of the fume and smoke given off during the smelting becomes deposited in the flues. The remainder which escapes from the chimney stack is widely scattered in a diluted condition by aerial currents. The dust which accumulates in the flues is very rich in Lead about 30% of metallic Lead, and so is worth recovering. Men enter the flues by man-holes and at places two or more feet of dust may be found. The removal of this deposit by the shovel raises clouds of dust. The workmen are thus exposed to the inhalation of Lead dust.

c. WHITE LEAD.

White Lead or Lead Carbonate is produced in several ways. Most of the White Lead sold in this country is made

by the "Dutch Process". In this process there are usually several stacks placed side by side in a row. The average size of a stack is 20 feet high and 16 feet x 13 feet. Upon the floor of the stack bark from a tan yard is strewn to a depth of 2 or 3 inches. On this bark are placed rows of earthenware pots, 6 or 7 inches high, and each half filled with a 2% solution of Acetic Acid. Thin perforated plates of Metallic Lead known as "Grids" or "Wickets" are placed sideways in the top of these earthenware jars. A layer of wooden planks is placed on these grids. This placing of the various parts continues until the stack is filled. Each stack is now called a "Blue Bed". The door of the stack is now closed and left for 3 to 4 months. The forming of the "Blue Bed" is not considered dangerous work and women may perform it. In a few days the temperature of the stack rises to between 50 and 60° Cent. due to the fermentation that takes place within the stack as the result of the bacteria present in the Tan. At the end of 3 or 4 months, the contents of the stack is called the "white Bed" and into this women are forbidden to enter owing to the danger of contracting Plumbism. Between the erection of the Blue Bed and its conversion into the White Bed, the following process takes place. Owing to the elevated temperature as the result of fermentation, the Acetic Acid evaporates and attacks the

metallic Lead Wickets and converts them into Lead Acetate. At the same time Carbonic Acid gas is evolved from the tan and a double chemical action takes place, the Lead Acetate is converted into Lead Hydroxycarbonate. Conversion of metallic Lead into the Carbonate is never quite complete and there is usually a trace of Lead Acetate between the metallic Lead and the Carbonate. The material is removed from the White Bed in wooden boxes by men or swung out of the stack by machinery and conveyed to the wash tubs to be crushed between wet rollers and washed so as to remove any Lead Acetate which may be present. The washed White Lead forms a pulp. This when completely sedimented and dried in an oven is White Lead.

The emptying of the stacks by hand labour was a dust raising procedure and the inhalation of the dust gave rise to more cases of plumbism than any other industry.

The Chamber Process.

In this process the sheets of Metallic Lead are thinner and longer than in the Dutch process. They are suspended over a set of rails in a chamber and the door is closed. Hot Acetic Acid Vapour and Carbon Dioxide gas are driven into the chamber from below. The chemical changes are similar to those which take place in the "Blue Bed" in the Dutch Process. In this process, however, conversion is more rapid. The temperature is kept at 60° C. for 50 or 60

days. Steam is then injected into the chamber to moisten the material and thus render it less dusty when being removed. Before men are permitted to enter and remove the white lead the chamber is allowed to cool for several days. This process is not so dangerous as the Dutch process and the danger also lies in the dust being raised and inhaled at the emptying of the chamber.

d. CHINA AND EARTHENWARE.

In North Staffordshire, this industry gives employment to 48,000 persons and of this number about ~~about~~ 8,000 are brought into contact with Lead.

The industry includes the manufacture of Earthenware, China, Tiles, Majolica Ware, Jet and Rockingham Ware, Sanitary Ware, Electrical fittings and China Furniture.

EARTHENWARE

This category includes the great bulk of opaque ware, plain and decorated made principally for domestic and general use, and the body is made of Ball Clay, China Clay, flint and stone. About 50% of the Lead Workers are employed in this work.

CHINA.

All translucent ware, generally speaking, is embraced in the term "china", but the great bulk of that made in this country contains a large percentage of calcined bone. In

some potteries, a translucent effect is obtained by the use of Felspar.

TILES.

In the manufacture of tiles, the material used is similar to that from which earthenware is made but instead of being worked in a plastic state, it is reduced to dust and moulded under pressure.

MAJOLICA WARE.

This name is used to denote decorative ware made of the same body as earthenware, but the glaze before application is mixed with colouring oxides or pigments.

JET AND ROCKINGHAM.

This class includes all articles made from simple brown clays unmixed with other ingredients and the glaze used contains either Cobalt or Manganese. In the former, the glaze becomes black and is known as Jet. In the latter it assumes a rich brown hue and is called Rockingham.

ELECTRIC FITTINGS AND CHINA FURNITURE.

In this class are included innumerable small pieces of ware of infinite variety, e.g. Door knobs, Castor rollers, insulators, finger plates and ink wells.

SANITARY WARE.

This includes the manufacture of Baths, Urinals and Lavatory Basins, some of which are made of a fine clay body and others with a body similar to earthenware.

USE OF LEAD.

Ordinary Earthenware and China bodies whether made of a simple local clay or of a more or less complex mixture of clay, stone, flint, bone and other substances are in themselves porous and would be quite useless for holding liquids unless the body was coated with a layer of impervious material. This impervious layer is known as the glaze and for centuries past compounds of lead have been widely used in its production. Lead also enters into the Pottery industry in the Decorative Processes.

GLAZES.

The particular compound most generally used in this country for ordinary Lead Glazes is the Carbonate of Lead (White Lead). For certain grades of pottery, glazes are used which have for their principal ingredient an oxide of Lead, (Red Lead or Litharge) or Lead Sulphide (Galena).

Glaze Processes.

The glaze is made by mixing Carbonate of Lead with the necessary Silicates and Silicoborates in the lead house or mixing room. Wet grinders prepare the glaze for the Dipping House.

"Putters up" hand the "Biscuit" Ware to the Dippers, from whom "takers off" place the dipped ware on boards for

removal to the drying still. Superfluous glaze has to be removed from the base and rims of the articles. This ware cleaning is performed with a wet sponge or flannel while the ware is still moist or by scraping if the ware is dry. In the former method, the particles fall into a vessel of water, while in the latter, the removal is done over a grating provided with a down draught.

The ware is next removed by the Glost Placer on boards and each piece is separately placed by him in the saggar (fine clay receptacles) and carried into the oven to be fired.

Decorative.

Majolica painting is the application of a coloured glaze, rich in lead, by means of a brush.

Ground laying consists in dusting powdered enamel colour on to a pattern first printed on glazed ware with an oily medium.

Aerographing (colour blowing) is the blowing on to the ware, by means of a jet of compressed air, colour glaze or enamel colour held in suspension in oil or other liquid in a glaze kettle or Aerograph instrument.

The dangers arise in dipping, the glaze splashes on to the face and overalls of the "Dipper", "Hander up" and "Taker off" and especially with plates as these are well shaken. The splashes dry and the overalls may become so coated with glaze that every movement, e.g. carrying boards,

crumbles it off as a dust into the air. As the Dipper shakes the ware, some drops are disseminated into the atmosphere as a fine spray.

In ware cleaning, the worker may remove the ware from the influence of the down draught and sometimes a ware cleaner is seen blowing away with her mouth dust lying on the ware.

Dipping boards, unless cleaned of adherent glaze by washing after use, create dust whenever ware is placed on or removed from them, when they are handled and placed on or taken off the stillage bars and when they are stacked. The glost placer raises a slight amount of dust as he takes the ware from the board and places it in the saggar. An old but very dangerous practice was the rubbing of the bottom or rims of cups either together or on a piece of leather fixed round the chest.

In Majolica dipping and painting (apart from the risk of splashing and contamination of hands) danger arises mostly from scraping the edges and under-surfaces of the articles on to which the glaze, when applying the background, has overflowed. The amount of glaze so removed is considerable and if not all caught in the trough of water, the floor becomes an added source of danger. In all decorative processes, the danger is one solely arising from the dust.

e. LITHO-TRANSFERS.

The enamel colours used in the patterns of transfers for the decoration of earthenware and china, contain a large percentage of lead. The enamel colours are dusted either mechanically in a machine or by hand by means of a pad of cotton wool. The danger arises from the dust disseminated through the atmosphere.

ELECTRIC ACCUMULATORS.

These are secondary batteries which serve for the storage of electricity in order to allow of a current when desired. In these batteries, the positive element is Peroxide of Lead and the negative element spongy Lead. These elements are placed in dilute Sulphuric Acid contained in Glass Vessels. The form of accumulator now in practically universal use is the pasted plate. The Litharge smeared on to one plate becomes converted into the positive element, Peroxide of Lead, and the Red Lead smeared on to the other becomes spongy lead to form the negative during the forming process, the passage of electricity through the dilute Sulphuric Acid in which they are placed. The plates are cast in moulds from a bath containing molten Lead and any irregularities in the plates are removed by a saw or knife or filed and brushed with a wire brush. The interstices of

the plates are next filled in by means of a spatula with paste of Litharge or Red Lead, as the case may be, which has been previously mixed either by hand or in a mixing machine. The plates are then dried and the batteries assembled, all the positive elements and all the negative elements are connected: a soldering iron or an oxyhydrogen blow pipe flame being used.

The dangers arise:-

(1) In casting, from the dust in depositing the skimmings and from fumes when old plates are melted down.

(2) In mixing and pasting, from the dust of the oxides of Lead.

(3) Filing or the use of a wire brush causing production of Metallic Lead dust and dust from the Oxides when the brush touches them.

(4) The fume produced by the high temperature of the blow pipe flame in assembling the plates.

GLASS CUTTING.

Red Lead enters largely into the mixture of raw materials for the manufacture of glass. Flint glass contains 43% of Lead. The raw materials (White Sand, Red Lead and generally Saltpetre) require careful mixing and cases of poisoning have been notified from the dust raised in seiving. Cut glass is polished on a brush by means of putty powder

(Oxide of Tin 29%, Lead Oxide 71%) mixed with water to a consistency of a paste. The brush revolves at a high speed and a fine spray of putty powder is thrown into the atmosphere of the workroom.

Rouge and Oxide of Iron have to some extent replaced the putty powder, but no substitute has so far been discovered to produce the final lustre necessary in the case of cut glass and lenses.

COACH PAINTING.

Lead poisoning is peculiarly prevalent in this industry. After the first or priming coat of paint which contains Lead is applied, it is smoothed. This smoothing is performed by two methods, the Wet and the Dry.

In the former, Pumice Stone and Water are used to smooth the coat of paint. In the latter the smoothing is done by sand paper. The use of sand paper is quicker and less expensive than the use of pumice stone and water, and the wet method cannot be used for Iron surfaces.

In the dry method, grave risk is present of inhaling the dust. In the Wet process, the substances fall on the floor, become dry and may rise into the atmosphere as dust.

In the case of house painters, Plumbism is also frequent and is due to the dust from sand-papering one surface of paint before applying another. They are also

exposed to risk when mixing White Lead with Oil on account of the dust raised, and the fumes which are given off when old paint is being burned off and dust arising from dried paint on overalls are sources of poisoning.

PAINTS AND COLOURS.

Most of the cases of Plumbism have occurred in the manufacture of White Lead paint but the manufacture of Chromate of Lead account for several.

In the manufacture of White Lead paint, the barrels containing the White Lead are opened and it is scooped into a pail. The Lead Carbonate is weighed and the necessary amount is then discharged either into a pugmill or into the pan of an edge runner and mixed with oil. The danger lies in the dust which is raised in opening the barrels, filling the pails and discharging the White Lead into the pugmill.

RED LEAD.

This is formed by placing pure Lead on the open hearth of a reverberating furnace and heating it to a dull redness. The material is raked at intervals. By oxidation, the Lead is converted into Lead Oxide, known as Litharge or Massicot and becomes yellowish red on being washed. The washing removes any Metallic Lead which has escaped oxidation. The Litharge is again heated but at a lower temperature, further oxidation takes place and the colour becomes bright

red. The danger arises from the fact that the fumes may be reflected on the workmen during the oxidising process if the flue of the furnace is not drawing well or the mouth of the furnace is not well hooded. The workmen may inhale the fumes or they may inhale or swallow the red lead itself when raking it out of the furnace or when packing it into barrels.

VITREOUS ENAMELLING.

Enamel glazes contain from 15% to 75% of Lead. Surfaces, e.g. sheet iron for advertisement signs, cast iron for baths and gas stoves, copper for letters and tablets, are treated with enamel glazes. Glaze is swilled on to the sheet of Iron. After drying it is fired or vitrified and upon this surface as many other coats of glaze are applied as may be necessary. When the colour is dry, lettering is effected by brushing away the dried but not fired glaze exposed through stencils.

In this process of brushing much dust is given off which contains various quantities of Lead which is inhaled and produces lead poisoning.

DESILVERISING.

Cases of Lead Poisoning from this process are not frequent. Lead contains a fairly large quantity of Silver which has to be extracted by means of making an amalgam of Lead with Zinc in the molten state. This method of

desilverising, the Parkes process, is not attended by Plumbism to any great extent. This process depends on the formation, on adding Zinc to a pot of molten metal, of crusts consisting of an alloy of Silver, Lead and Zinc. The crusts, after cooling, are broken up, placed in a crucible and the Zinc is driven off at a temperature of 1000° C. The rich bullion remaining in the crucible next undergoes cupellation i.e. exposure to a blast of air in a furnace. The lead is oxidised into Litharge which drops into a receptacle below the furnace leaving the silver behind. The other process, the Pattison process depends on the higher temperature of crystallization of Lead than of an alloy of Lead and Silver which enables a separation of one from the other to be made. by a process of ladling the crystalline portion from the liquid portion.

Plumbism when it does occur is due to the inhalation of fumes from the molten metal.

PRINTING.

Type metal is an alloy consisting of Lead 75% and Antimony 25%. the latter giving hardness to the Type. Printing by the old method, viz. by hand setting of the type was not healthy, and the number of notified cases have been reduced by 60% principally by the substitution of Linotyping for the old method. Some cases of Plumbism are due to the

fumes given off from the casting pot or lino-melting pot and some may be due to the cutaneous absorption of Lead by handling the type. The dust in printing shops created during the wear and tear of type has been found to contain 14% of Lead (Cliver) The inhalation of the atmosphere would cause Lead Poisoning.

FILE CUTTINGS.

Plumbism from this industry is diminishing very rapidly on account of machinery replacing the former hand method. In the old method, the file was placed on a bed of Metallic Lead. By means of a hammer and chisel fine lines were made on the file, each line representing a blow by the hammer. During this process, a considerable amount of xx dust is raised and although the Lead is mostly in the metallic state, some oxidation takes place and so renders the Lead capable of absorption. File cutters very frequently bend over the file during the cutting and thus inhale the dust directly from the leaden bed.

In the hardening of files, they are dipped into a bath of molten lead.

The men who dip the files frequently suffer from Plumbism due to the fumes of the molten metal.

OTHER INDUSTRIES.

The workers in numerous industries other than those mentioned are liable to suffer from Plumbism. The following

are examples.

(a) The making of Lead Caps for the corks of bottles.

(b) The making of measuring tapes.

(c) The making of shot.

(d) The tempering of buffer springs and (e) the manufacture of rubber.

In these industries the danger arises from the inhalation of an atmosphere containing lead particles.

PREVENTION AND TREATMENT.

Before taking up the methods of prevention and treatment of Lead Poisoning, it would be better to study the manner in which Lead enters the body.

The channels through which Lead or its compounds may enter the body are:-

1. Cutaneous,
2. Respiratory,
3. Gastro-intestinal.

There is considerable diversity of opinion as to the possibility of the absorption of Lead through the unbroken skin. Some drugs have shown their effects after absorption through the unbroken skin, e. g. Belladonna may produce dilatation of the pupil, Salicylic Acid Ointment when rubbed into the skin may be followed by the appearance of the derivatives of Salicylic Acid in the Urine. Lead cannot absolutely be excluded from this category. There are many objections to this however. Lead workers who are constantly manipulating Lead in a state of solution with bare hands do not as a class appear to be more susceptible to wrist drop than workers who are exposed to inhalation of fumes or dust of Lead.-

The relative importance of the other two channels of

absorption is very much disputed.

Legge and Goadby demonstrate that inhalation of lead particles plays a very important part in the incidence of Lead Poisoning.

Oliver, however, states that the Gastro-intestinal tract is the chief channel of entrance and absorption, on account of the worker swallowing some of the lead compounds. Both channels can play an important part in the production of lead compounds, but the weight of evidence seems, in my opinion, to be in favour of the Respiratory System being the source of greater absorption.

From statistics it is evident that it has always been in these processes, in which the Lead is disseminated in the atmosphere as dust, that are the most dangerous. Under such conditions the worker must inhale numerous particles of lead dust. In the cases which have come to my notice, a larger proportion is in those who have been exposed to the inhalation of lead dust.

It is recorded that persons living at a distance from Lead Works have shown definite evidence of Plumbism although they were not engaged in any capacity using Lead or a compound. The evidence that lead dust in the atmosphere is capable of causing Lead Poisoning is in this instance conclusive. Melliere states that the Lead particles [redacted] deposited on the

mucous membrane of the mouth are swallowed and so set up Lead Poisoning. Particles of dust may quite readily become directly deposited in the lung as is observed frequently, e.g. deposits of carbon in the lungs of town dwellers, or of flinty material in Stone-grinders' Pneumokoniosis.

A preventive measure which has been of considerable importance in reducing the number of cases of Plumbism is by keeping the lead compounds in the various processes in a wet condition and so preventing aerial dissemination. If the absorption had been taking place by the alimentary tract the reduction in the number of cases would not have been so apparent because the worker would be as liable to swallow lead in the wet condition as in the dry state. The lead compounds were usually conveyed to the mouth from dirty fingers of careless workers.

The important channels therefore are:-

1. Respiratory
2. Gastro-intestinal.

Glazes free from Lead have been tried in this district viz. The Potteries, but they have on the whole been extremely unsatisfactory.

It has been shown that a leadless glaze is a moderately good substitute for glazing the cheapest type of ware but for

the medium and better class a lead glaze is essential. The number of "seconds" (pieces not of first rate finish which consequently cannot be sold at full market value) had greatly increased, so that from the view of the manufacturer, it did not show itself to be a good substitute.

The covering which a lead glaze gives, whether to earthenware or china " bodies", is more perfect than any that can be obtained by other means, and in consequence the goods are more marketable. The Departmental Committee appointed in 1908 after discussing the possibility of using a leadless glaze, came to the conclusion that such a course was impracticable.

A Departmental Committee was set up in 1911 to enquire into Lead Poisoning among Painters, but the Committee came to the conclusion that so far a proper substitute had not been found for White Lead. Efforts have also been made abroad to replace White Lead by other substances but have not met with much success.

For internal decorations, Zinc White could replace White Lead with a fair amount of success. The qualities which a paint must possess to have a good commercial value are, good covering power and durability, capable of mixing well with oil, and not too expensive.

These properties are possessed in a marked degree by Lead Carbonate made by the Dutch Process, but are not possessed by Zinc White to the same extent. Zinc White mixes well with

oil, has good covering power, but it is not so durable and is apt to peel off. Hence as a commercial proposition must be classed as a failure.

Lithopone is stated to be a substitute for White Lead and is composed of Zinc Sulphate 25-33% and Barium Sulphate 66-75%. This substitute is used for cornice poles and rings. It is evident that each of these substitutes for Lead Carbonate may each be used for a small certain class of articles, but for a more extensive use, nothing has been found to replace Lead Carbonate.

As the use of White Lead cannot be eliminated it is necessary to study the ways and means of reducing the liability of the worker in Lead from its pernicious effects.

The two statements,

1. Personal cleanliness of the worker.

2. Abolition of lead dust from the atmosphere,

may be stated to sum up the quintessence of prevention.

Both the worker and the employer have a very important role to play and hence the responsibility is jointly held.

All persons who have been engaged to work in any process which brings them in contact with Lead in any form should be medically examined before commencing work. If the person is found to be suffering from any form of Tuberculosis, Alcoholism, Oral Sepsis, Renal Disease; and in Women, Pregnancy or a history of miscarriage, then that person should not be permitted

to commence work.

After a person has been passed by a Surgeon as fit to work in a lead process too much stress cannot be laid on the instructions which the worker should receive. These instructions should be given verbally and also in the form of a leaflet to explain how poisoning by Lead is caused and the means in his power to prevent it or if coming at some future time under the influence of Lead, the preliminary symptoms which he at once should report. The importance of observing these instructions must be impressed on the worker and it is the duty of the employer and foreman to see that these instructions are being obeyed. The conditions which are liable to be set up are:-

Unnecessary creation of dust. This may be caused by cleaning the bench with a brush instead of by the Wet Method.

Receptacles containing Lead Carbonate may be knocked thereby causing some of the compound to be disseminated into the atmosphere. Many workers bite their nails. The moustache and the beard may be fingered and so workers are advised to be clean-shaven.

The following may be taken as an example of the points which are given to employees commencing work in a Lead Process.

Working in Lead or Lead compounds may be detrimental to health because the Lead enters the system and causes poisoning.

The danger lies in breathing air which is contaminated with Lead dust or fume, but eating with unwashed hands, biting the nails, placing sweets, pipes, or tobacco in the mouth with soiled hands, all contribute to cause Lead Poisoning.

Lead Poisoning usually appears very slowly and the first symptoms of its effects on the system may be constipation, colicky pains in the stomach, headache and paleness. The headache is sometimes associated with Epileptic Fits and may be followed by loss of sight.

Permanent disablement from work may be caused by paralysis of the muscles moving the wrist and fingers due to the action of Lead. Lead may be taken into the system in extremely small quantities where it has a tendency to remain, and unless care is taken it will accumulate and cause permanent ill health.

Women must be exceedingly careful because Lead not only affects the parent, but will seriously interfere with the health of the offspring.

Lead does not enter through the skin, therefore poisoning can in a great measure be prevented by taking special care not to raise dust. Any little cloud constantly present at work will, if breathed, set up Lead Poisoning.

If there is any defect in the ventilating arrangements of the work-shop it is the duty of the worker to report such defect to the foreman immediately. Where Lead is used wet, it

may be splashed on a wall, floors, or on overalls, and if allowed to become dry it forms a dust which may set up poisoning.

Great attention must be paid to the cleanliness of the hands, face, teeth and clothing. The hands and nails must always be cleaned thoroughly with soap and a nail brush before food is taken and the mouth rinsed out. The teeth should also be kept clean.

Food should always be taken before commencing work.

Overalls should not be shaken as this will cause dust in the air. They should be washed at least once a week.

Aperient medicine such as Epsom Salts (one or two teaspoonfuls in water) can be taken once or twice a week with advantage by lead workers.

Intemperate persons are the first to fall victims to Lead Poisoning.

Medical advice should be obtained immediately if any of the symptoms mentioned above present themselves.

... ...

Baths. In several factories, baths are provided for the use of the workers and the use of them makes for improvement in general health. Provision of bath accommodation is required under the special rules for White Lead Factories.

Overalls and Headcoverings.

These should be worn by all workers in a lead process, and should be washed or renewed once a week at least. They should be made of unbleached linen. These prevent lead dust from settling on the clothing of the worker. They also provide protection for clothing in occupations in which splashing is incidental to the operations and in this case some light waterproof material, well ventilated may be used, either to make the overall, or as an apron covering the front of the overall. Sponging in this case would replace washing.

It is the duty of the occupier to provide for the washing, renewal and necessary repairs of the overalls and headcoverings and this may be done either at the works or at a laundry. Uninstructed laundresses have been known to contract Lead Poisoning by shaking the overalls prior to washing them, so that it is advantageous to have the overalls and head coverings washed in the factory by women who have been instructed in the precautions necessary when dealing with these articles.

When the overalls, head coverings and aprons are not in use they must be kept in a cupboard set aside for the purpose and under proper custody. The outdoor clothing of the worker is kept in a special room provided with cupboards which is quite separated from any source of Lead dust and separated from the room in which the working clothes are kept.

Lavatories.

In nearly all the regulations the following requirement is laid down. The occupier should provide and maintain in good repair suitable lavatory accommodation (at least one lavatory basin for each five persons, with hot and cold water, soap, nail brushes, and an adequate supply of clean towels, for all persons employed in a lead process. A responsible person is usually placed in charge of this department who has a two-fold duty to perform: (1) to keep the place clean and ensure the necessary materials for ablution, (2) to see that the workers avail themselves of the facilities which are provided. The workers at meal times and at the end of the day, take off their overalls and head-coverings in one room, proceed to the lavatories in the adjoining room and after washing proceed to the next room for their outdoor clothing.

Mess Room accommodation.

Wherever a lead process is carried on, the provision of a mess room is necessary and should be placed in a part of the factory remote from possible contamination with lead dust. The mess room should be sufficiently large to accommodate all the workers in the lead processes, and it should be clean, well ventilated, well lighted and warmed. The walls of the mess room should consist of glazed tiles to a height of four feet from the ground. It should be provided with pigeon-holes in

which each worker may deposit his food, separate from that of others. Reid (Memorandum on Mess Room Accommodation of the Potteries, Committee Report 1910, Vol. II) suggests the following scale of floor space per person in the mess rooms:-

viz.	6	persons	and	under		10½	sq.	ft.	per	person.
over	6	"	and	up	to	12	7½	"	"	"	"
"	12	"	"	"	"	20	6	"	"	"	"
"	20	"	"	"	"	28	5½	"	"	"	"
"	28	"	"	"	"	any number	5	"	"	"	"

No person is allowed to take into the mess room any overall, headcovering or apron in a lead process. The washing conveniences shall not be maintained in the mess room, nor may the mess room be used for any manufacturing process.

No person should commence work on an empty stomach in any lead process, and the food-stuffs which are particularly useful in preventing the onset of poisoning are Albuminous and fatty foods viz. meat, eggs, milk and fats. It would therefore be to the advantage both of the employer and the employee, to have milk or cocoa made with milk, supplied to each employee before commencing work in the morning. To the former it would reduce the amount of compensation to be paid and to the latter, diminishing the risk of Lead Poisoning. Experiments on animals demonstrate that poisoning by Lead appears much quicker in those which have not had a sufficiency

of food.

Workrooms:-

Provisions against dust:-

During recent years this has received more attention than any other preventive measure. Duckering in 1910 submitted a "Report on an investigation of the air of work-places in Potteries". In a Dipping Room where low solubility glaze was used, the amount of Lead in the dust collected per ten cubic metres of air was 0. 70 milligrammes. The average of four experiments where no dipping boards were used, was 1.80 milligrammes of Lead and where dipping boards were used 3.75 milligrammes, i.e. 1.95 milligrammes of Lead in the dust is added by using dirty dipping boards. A very fine spray is given off from the ware during the process of shaking and in a bright sunlight this spray can be seen well above the dipping tub.

In considering preventative measures, precedence is given to the removal of dust by exhaust ventilation.

Exhaust by heat:-

This is more particularly used in processes giving rise to fumes or to dust liberated on stirring or skimming. Over the bath of molten metal, a hood is placed which leads into a duct in which there is a draught created by the furnace flue. There is however a disadvantage in this method namely

the uncertainly and inequality of the draught and the size of the duct necessary to cope with the volume of rarefied air from above the molten metal.

The closer the hood is to the point where the fumes escape the less liability is there of the cross currents deflecting the fumes into the workroom. Hence all baths of molten metal should have the sides and back closed in, leaving the minimum necessary space in front for skimming or stirring.

The variableness of the draught produced by heat, makes it unsuitable for the removal of dust.

Exhaust by Fans:-

Dust is more effectively removed by fans of which there are two types.-

1. Low pressure volume fans.
2. High pressure centrifugal fans.

In the first type the draught is created by the rotation of a wheel with inclined vanes, causing the air to be driven transversely through the wheel paralled to the axis of rotation.

The main defect of this type of fan is the inability to overcome any except slight resistance in the course of suction behind, as from constriction in, or friction along the sides of, the ducts and right-angled bends, or of outflow in front such as may be caused by wind pressure. In order

to avoid resistance from friction the ducts must be somewhat larger in diameter than where the second type of fan is used. All fans require frequent cleaning and the propellar fans have the advantage over the centrifugal type in that they are more easy of access.

Centrifugal Fans:-

In this type the fan wheel is formed by a number of vanes attached to an axle mounted in a spiral shaped casing. When the wheel rotates, air is carried along by the vanes and flies off tangentially into the space between the blades and the casing and thence to the outlet. In the removal of dust the advantage of this type over the former, lies in the fact that this fan is capable of overcoming a greater internal resistance.

Ducts:-

The main duct should be made of metal (steel or zinc) It should be circular in shape and have as straight and short a course as possible. If at any point some branch ducts enter the main duct then the area of the cross section of the main duct should equal the combined areas of all the branch ducts. Branch ducts should enter the main duct at an angle of 30° or less as by so doing the two or more currents of dust-laden air do not impinge on each other and hence do not neutralise each other. Branch ducts should also join up on the inside of a

bend where the pressure is considerably less than at the outer side. Right-angled joints should never be used as these diminish the draught by nearly one half.

Hoods and Air Guides.-

The function of Hoods is to concentrate the draught on the dust to be removed from the workers, and hence the essential feature is the position of the hood with regard to the origin of the dust. The more restricted the opening in the hood, provided it does not interfere with the work, the more effective is the draught and the less will it be liable to be disturbed by the crosscurrents in the workroom. It is also important that the draught should be below the breathing level.

The exhaust current may have various directions, namely downwards, downwards and backwards, upwards and backwards, and upwards. It has been proved that the most efficient are those directed downwards or downwards and backwards. It is essential that the hoods should be adjustable to cope with large and small articles.

This method of exhaust ventilation is particularly important in the Potteries in the processes of colour grinding and aerographing.

At the distal side of the fan a dust chamber was situated or an attempt was made to blow the dust into a tank

of water. These however did not prove satisfactory and are now replaced by filter bags made of some porous material. In collecting the dust it is essential that an adequate outlet is provided for the spent air so as to prevent the creation of a source of friction which could destroy the efficiency of the exhaust draught.

The efficiency of this installation is minimised and may actually give a false impression of security, unless the hood, air guides and fans are maintained in a clean condition The cleaning is not free from danger and the cleaner must wear a respirator and the exhaust draught must be in action while the cleaning is taking place.

While the exhaust ventilation is a great essential for the removal of dust, the general ventilation of the work-rooms is as important. The fresh air inlets are situated about six feet from the floor and fitted with "Hopper" openings so that the entering air is deflected in an upward direction. Where natural air currents are insufficient the installation of fans is essential.

Care is necessary that the draught cannot blow directly from the fresh air inlets on to the workers. The fresh air inlets should be situated so that it is impossible for any extraneous dust to be drawn towards the workers by the exhaust draught.

The general efficiency of the exhaust draught may be tested by holding smoked paper at the inlet of the hood. It can, however, be accurately determined by the anemometer.

PERIODICAL EXAMINATION BY CERTIFYING SURGEON.

In the Potteries, all employees of firms using more than 5% of Lead in the glaze must be examined at least once per month by a Surgeon. The term Surgeon is defined as the Certifying factory Surgeon of the district or a duly qualified Medical Practitioner appointed by written certificate of the chief inspector of factories, which appointment shall be subject to such conditions as may be specified in that certificate. The Certifying Surgeon's duty is to examine the workers at stated intervals and at definite times and to keep a record of his examinations in a health register which is supplied to all occupiers and kept by the occupier. No person may be employed in any process involving contact with Lead until he or she has been examined and passed as fit by the Surgeon to be employed in a Lead process nor may an employee recommence work in a lead process after having been suspended until passed as fit to do so by the Certifying Surgeon. The Surgeon has very onerous duties to perform. It is his duty to diagnose cases of Lead absorption and so by advice prevent the onset of Lead Poisoning. He must have a very intimate knowledge of the various lead processes and if a case of Plumbism should arise, it is his duty to

elucidate the cause and suggest measures for the prevention of others. He may also be required to treat cases of Plumbism. Should it become necessary to suspend a worker from a Lead process, the Surgeon recognises that it is desirable to transfer the worker to a non-lead process rather than entirely suspend him from work. The Surgeon, therefore, should know what departments are possible alternatives to Lead work. In the Potteries the periodical examination is monthly, but in some industries, e.g. White Lead Works, the examination is weekly, whereas in others, e.g. Tinning, Yarn dyeing and Chromate of Lead, the examination is quarterly. In instances however in the latter manufactures, the Home Office has ordered weekly examinations on account of several cases of Plumbism having been notified. When the number of cases ceases to increase, the Home Office may then order monthly examinations and finally revert to the standard, namely quarterly.

Surgeons in the past used to make the examinations of the employees at irregular intervals so as to prevent any undue preparations for the examinations. This method had its advantages, but workers might be unavoidably absent, e.g. night-workers on whom a hardship was inflicted.

At the present, however, the time and date of the Surgeon's visit is posted in a conspicuous place so that excuse for absence is difficult. Notice is also sent by

the Factory Surgeon beforehand of any alteration in the time of his visit.

For the examination a well-lighted room affording privacy is necessary and the workers should be examined individually. The majority of Lead workers do not consider that the examination is to benefit them and to afford them protection against Lead Poisoning, and hence they are very liable to conceal their symptoms and attempt to mislead the Surgeon. The examination, therefore, is principally an objective one, and by repeated interrogation at the various examinations the Surgeon is soon able to study the characteristics of the various individuals.

Especial care is necessary in the examination of all new workers in a Lead process and they are brought to the notice of the Surgeon on his first visit. Before commencing work they are examined as to their ability to undertake this type of work. Tuberculosis, Alcoholism, Renal Disease, Epilepsy, Feeble-mindedness, Chronic Plumbism, Myopia not corrected by Lenses in a person, should each be sufficient reason for rejection, and the appearance of any of them in a Lead worker would be sufficient reason for suspension, as these individuals would be unduly susceptible to the action of Lead. Pregnant women, or women with a history of miscarriages, should be at once suspended. Alcoholism renders

a person more susceptible to the action of Lead.

New workers are closely watched by the Surgeon. The new worker requires advice in the preventive measures, he is more liable to be attacked in the first year of employment, and signs of Plumbism in a new worker demonstrate either peculiar susceptibility or, which is commoner, defect in the preventive measures.

The employment of casual labour in any Lead-process should be discouraged, and tradesmen who may be temporarily employed in the Lead Workrooms should be warned of the dangers of raising dust and be carefully watched, as they do not realise the dangers surrounding them.

At the monthly examination of the Lead workers in the Potteries, the following may be taken as the usual routine of the examination:-

The general appearance of the worker as he walks towards the Examining Surgeon. The gait is important, and it may be necessary to ask the man to walk round the room. The Peroneal type of paralysis is uncommon, but it will be noticed in the gait if present.

The appearance of the face is usually one of anaemia. In the majority of cases of early lead absorption the pallor is not entirely due to anaemia but in part due to vasomotor spasm of the arterioles of the face. Frequently on speaking

to a Lead worker, the face apparently anaemic flushes.

The appearance of the eyes as to brightness, state of the pupils, and the colour of the conjunctiva and state of the ocular muscles, next have attention. Dilated pupils, with sluggish reaction to light, are frequently seen in the later stages of Lead absorption.

The mouth is next examined, and by separating the lips any evidence of blue line or oral sepsis is observed. Sometimes the Buccal mucous membrane is examined for blue discolouration.

The worker is next directed to stretch out his hands in front of him with wrists extended and fingers spread out. The presence or absence of tremor is noticed, and the condition of the finger nails denoting especially the practice of biting them.

The extensor power is then examined first of the fingers. To elicit this, the Surgeon places the forefinger of his hand in the outstretched palm of the workman and the ball of the thumb on the extreme tip of each finger and by gently pulling it down noting the spring present in the muscles. This test is very delicate for noting the early detection of extensor paralysis.

To test the condition of the Lumbrical and Interossei muscles, the worker is asked to adduct and abduct the fingers

to and from the middle finger.

The extensor power of the wrist is next examined, and may be ascertained by asking the worker to flex and extend the wrist, the arm meanwhile being extended with the palm directed downwards. The power of pronation and supination is next elicited. The worker is then told to close the fist, and the Surgeon then endeavours to flex the wrist, the worker meanwhile resisting by forcible extension of the wrist.

Any wasting of the muscles of the Thenar and Hypothenar eminences is shown by flattening of these parts of the hands.

The Pulse is next noted. The pulse rate need not be counted, but if it is either very fast or very slow careful examination at the conclusion of the general inspection is made.

After completion of the objective examination the Surgeon may enquire as to the state of the Bowels, whether regular or otherwise, the existence of Headache or any pains in the abdomen. The speech is noted, as a slurring or hesitating speech is occasionally associated with early Lead Poisoning.

All these points can be gone through quite rapidly, and if there is any doubt in the mind of the Surgeon, the

worker is required to wait until the examination of the others has been completed, when a more complete examination is made.

If a worker is found to be suffering from the toxic effects of Lead Absorption as shown by marked or progressive anaemia, or paralysis, he is at once removed from his usual work and an entry is made to the effect in the Health Register.

This may mean entire suspension from work altogether, or it is more usual to give employment to the worker, in another part of the factory away from any possible contact with Lead, unless he is on the borderline of definite Plumbism, when any work is inadvisable. The part of the factory in which the worker was employed is inspected by the Surgeon to see if this employee's condition is due to some defect in the preventive measures which can be remedied.

When the worker's condition renders him unfit for any employment, he is, for the time he is incapacitated, paid compensation.

The Health Register in general use where periodic medical examination is required is divided into two sections, in each of which entries by the Surgeon are required at each visit.

PART I.

List of Persons employed in Process					Particulars of Examination.		
No.	Workers' name in full.	Process	First employed in such process.		Date Result	Date Result	Date Result
			Age.	Date.			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

PART II.

Reference to Part I. Page Column		Date of Examination.	Number of Persons Examined.	Particulars of any directions given by the Surgeon. Any certificate of Suspension, or certificate permitting resumption of work must be entered here in full.	Signature of Surgeon.
(1)	(2)	(3)	(4)	(5)	(6)

In Part I. of the Register the Surgeon at the time of the examination enters the date at the head of one of the columns numbered 6-8 in the space below, opposite the name of each person examined on that date a brief note of the condition found.

In Part II. he enters in Column (3) the date of the examination and in Column (4) the total number of persons examined on that date. In Column (5) the Surgeon enters any certificate of suspension from work or certificate permitting resumption of work and particulars of any directions given. In Column (6) the Surgeon appends his signature.

It is the duty of the occupier to complete columns (1), (2), (3), (4) and (5), and these particulars of each person employed must be entered immediately on commencing work in the process named.

Columns 6, 7, 8 etc, of Part I. and all the Columns of Part II. are completed by the Surgeon.

The object of the Register is to keep an intelligible record for the use of the Certifying Surgeon, Factory Inspector, Employer and Employee.

A uniform system of entry is advisable which takes into account the two aspects of the health of every head worker (a) Indicative of specific effects from the occupation, (b) General state of health uninfluenced by the employment.

By a series of symbols the register is kept easily and completely and this is permitted by the Home Office, provided the interpretation of the symbols is stated in some portion of the register.

Numerals are used to indicate degrees of deviation from normal health which may in whole or in part be attributable to work in Lead. Letters are used to indicate deviation from health not attributable to working in Lead.

The conclusion is best expressed as a fraction,

e.g. $\frac{1}{A}$ $\frac{2}{A}$ $\frac{3}{C}$

Meaning of numerals:

1. Passed without comment (no observed effect of Lead)
2. Blue Line. Anaemia.
3. Marked Anaemia. Albuminuria.
   Loss of power of extensor muscles.
4. Suspension or transfer to other work due to impairment of health due to toxic effects of Lead.

Meaning of Letters:

A. No comment.

B. Impairment of health, not due to Lead.

C. Pregnancy.

D. Suspension from working in Lead owing to impairment of health due to other causes.

The Surgeon in addition to entering details in the Health Register which he is obliged to do, frequently keeps for his information a notebook in which he enters more complete notes of the examination.

The Surgeon notes from visit to visit the effects of Lead on the workers, keeps a record of these which may show evidence of Lead Absorption and he endeavours to prevent the onset of Plumbism.

It is essential to distinguish between the two states, namely (1) Lead Absorption sometimes called the Presaturnine State and (2) Lead Poisoning or Plumbism.

Plumbism is a definite disabling disease, but Lead Absorption is the prodromal state of the disease and cannot be defined as actual Lead Poisoning, and in many cases, workers may show definite evidence of Lead Absorption, but their power of elimination is such that it can cope with the rate of absorption and so poisoning is prevented.

When, however, the rate of absorption is greater than the power of elimination, definite Plumbism is sure to follow.

For some considerable time, it has been customary in the treatment of men employed in Lead Works to give an occasional purgative, and it is a proper precaution to keep a quantity of a Saline Aperient, e.g. Magnesium Sulphate or Sodium Sulphate, in the works in the charge of some responsible person, viz. the foreman, so that any worker who desires an

aperient may have it for the asking.

The greatest proportion of the Lead absorbed is excreted by the Intestine and therefore the sweeping away of the Bowel contents, - particularly in cases where constipation is present - will tend to remove from the body a good deal of the lead which has been excreted into the bowel and which might possibly be re-absorbed if not removed.

In some factories, chocolate tablets are supplied to the workers which contain Sodium Hyposulphite.

At other factories a more palatable mixture is supplied. It is Magnesium Sulphate combined with Dilute Sulphuric Acid and flavoured with Lemon. This mixture was originally given on the presumption that Lead Poisoning took place on account of the dust swallowed and that the mixture formed an insoluble Lead Sulphate in the Stomach. These, however, have been proved to be fallacious, but nevertheless the mixture is extremely useful. In some factories, e.g. Smelting, some form of lemonade is supplied containing a few grains of Sodium Citrate to the ounce. Lead increases the viscosity of the blood and a drink containing a few grains of Sodium Citrate to the ounce flavoured with lemon is freely taken by the workers and this helps to counteract the effect.

As a routine measure it is advisable to stock at the factory a mixture containing Iron. The Surgeon at his periodical examinations takes a note of those workers suffering

from anaemia. Those workers are instructed to attend regularly after meals to obtain a dose of an iron mixture containing Magnesium Sulphate from the foreman. The Surgeon thus selects the persons requiring treatment, and the foreman sees that they attend for their medicine.

The presence of Alcoholism or the onset of any of the diseases already enumerated which are known to be predisposing causes of Lead Poisoning should be sufficient to determine the transfer of any worker from the dangerous processes.

The treatment of Plumbism as the treatment of Lead absorption is directed towards the elimination of the poison, the repair of the damaged tissues and special treatment of those organs which suffer specially in Plumbism.

In treating the urgent symptoms by special methods the general treatment for the elimination of the toxin must not be neglected.

The channel through which the poison leaves the body is mainly by the intestine. Treatment must primarily be directed towards the elimination of the poison by this route, both by the use of enemata and later by Magnesium Sulphate, and it is better in cases of obstinate constipation and colic to give enemata than to continue to administer huge doses of purgatives, such as Croton Oil, Elaterium, Magnesium Sulphate, or Castor Oil.

The commonest symptom is colic, and this may be Simple, Acute, Recurrent, or Chronic. In this state the patient complains of great pain referred to the Umbilicus or lower abdomen. Occasionally diarrhoea is complained of, but obstinate constipation is very much more frequent. In Acute Colic, the pain passes off in the course of 5 or 6 days, generally disappearing about 4 days after the lower bowel has been thoroughly cleared out. The pain is usually paroxysmal, rarely persistent. Vomiting may or may not be present, though nausea is usual.

Recurrent Colic is as a rule less severe than the Acute Type but may last for several weeks, clearing up for 3 or 4 days at a time and then recurring with little diminution in violence from the first attack. Such cases are thought to be due to the gradual excretion of Lead by the intestine. In the Chronic form the pain may persist for two months during the whole of which time the patient complains of uneasiness or even constant pain in the lower part of the abdomen. The pain becomes worse after each motion of the bowels, and this type is usually associated with obstinate constipation.

In the treatment of Lead Colic, we have to treat the pain, vomiting and constipation. In the milder forms of abdominal pain, heat applied as a fomentation, or as a poultice, and pressure on the abdomen is often sufficient.

In the severer forms, however, a hypodermic injection of Morphia, gr. 1/6 to gr. ½, is necessary, and this helps to allay the vomiting. The intestine, however, must be treated and cleared of faeces, and to do this the patient is given Croton Oil m. ½ followed in 8 hours by a similar dose. At the same time the lower bowel is cleared by an enema of two pints of normal saline. After two or three days Croton Oil may be again given. When the bowels have been moved, Magnesium Sulphate may be substituted for the Croton Oil. During the attack of Colic and for several days after the attack has subsided, the patient's food is confined to milk which is fully citrated with Sodium Citrate. Gradually the diet becomes more liberal, farinaceous foods being added, but butcher's meat is not given for about 10 to 14 days. Alcohol in any form is entirely withheld.

By this treatment, the lead which is lying in the intestinal canal and any that may be excreted into the canal, is cleared out. The use of Potassium Iodide in the treatment of Lead Colic has fallen into disuse in the Potteries. The action of Potassium Iodide is stated to be one of converting the insoluble Lead Albuminate into a Soluble Lead Iodide which is excreted into the Intestine. If, however, much Lead Albuminate is present in the tissues, the administration of Potassium Iodide may set free much Lead Iodide

which circulates in the blood stream and may thus cause a fresh train of symptoms.

The patient may develop Encephalopathy or paralysis, which were not present previous to taking Potassium Iodide.

Other drugs suggested in the treatment of Lead Colic are, inhalations of Chloroform, inhalations of Nitrite of Amyl, but their action is only temporary. Scopolamine is also useful. It takes longer to act but the effects are of longer duration. Sodium Nitrite and Liquor Trinitrini may also be used.

During an attack of Colic, the pulse rate decreases and the blood pressure rises, so that the administration of Vaso-dilator drugs is indicated.

Whatever purgative is used, it is well to combine with it some anodyne, e.g. Tincture of Opium.

ANAEMIA.

In the treatment of Anaemia, the patient must be removed from the dangerous work and employed in the fresh air. Iron and Arsenic are used in combination with Magnesium Sulphate. Any constipating effect of the Iron must be avoided, and a liberal supply of milk should be taken. The administration of Potassium Iodide must be given with extreme caution if at all, for the reason already given.

NERVOUS SYSTEM.

Certain evidences of affection of the nervous system may be seen in the stage of Lead absorption. They may be temporary and disappear under treatment, by change of employment, and hence reduction of the Lead absorbed. Thus dilatation of the pupils - the reaction to light being extremely sluggish - is often present in the later stages of Lead absorption.

Tremor may also be a symptom.

The general treatment is the same as for Anaemia, namely administration of Iron, Arsenic, and prevention of Constipation.

Strychnine should not be given when there is any tendency to Colic.

For the paralysis of the muscles, massage with passive movements, combined with electricity, should be used.

Either Faradism or Galvanism may be used, and at the first the minimum current giving a contraction should be used. In the early stages a greater current can be borne by the patient than in the later stages when the muscles and nerves commence to recover.

One pole of the battery is placed over the affected muscles and the other pole is placed in a basin of water into which the patient's hand is dipped. The current is

applied for half an hour at a time and may be applied twice in twenty-four hours.

For affections of the lower limbs, the application may be made by means of one of the usual baths in which the foot is immersed, the other electrode being placed over the affected muscles. Subsequent to electrical treatment the part should be well rubbed, and passive movements as well as massage are performed to promote the return of the normal function.

When treated early, Lead Paresis frequently recovers, and a person suffering from Lead Paresis for the first time, confined only to the hands or to a group of muscles of the shoulder, the outlook is good. In paresis of the lower limbs, the prognosis is not so good.

Oliver in his "Diseases of Occupations" describes the double electrical bath. The patient sits on a chair with his hands in one bath and his feet in another. Into the baths a solution of Sodium Chloride is put. Into the hand-bath, the negative pole is put and into the foot bath the positive pole. The poles are formed of aluminium grids. The current from an eight-cell accumulator is gradually turned on and the effect of the current is to ionise the lead in the tissues. The lead passes to the negative pole. The use of the double electrical bath has not met with general acceptance.

The typical form of affection of the Central Nervous System is Encephalopathy, shown by Epileptiform Seizures. Chronic headache may precede these seizures, and headache in a Lead worker should be regarded with grave suspicion.

In the treatment, elimination of the poison is of paramount importance. Amyl Nitrite may be inhaled and Bromides may be given by the mouth or rectum. Lumbar Puncture may be performed. The patient should be kept quiet, given a light nutritious diet, and attention paid to the bowels.

Under no circumstances should a person who has suffered from Encephalopathy or Cerebral Symptom of Lead Poisoning be allowed to resume work in a Lead Process.

PROGNOSIS.

The prognosis of the first attack of Lead Poisoning of simple colic, or slight unilateral paresis is good. Practically all cases recover under treatment. It is unusual for a person to succumb to the first attack of colic or paresis.

In most cases the serious forms of poisoning only make their appearance after three or four previous attacks of colic, but a single attack of paresis is more frequently followed by a severe form of poisoning such as Encephalopathy.

Susceptibility to Lead poisoning is observed in some

individuals. Persons in whom this idiosyncrasy is observed should be refused permission to work in a Lead Process. Alcoholics show a marked tendency to the effects of lead, resulting in Paralysis and Mental symptoms, and the prognosis in this type of person is much less favourable than in an abstainer.

Females contracting Lead poisoning which causes abortion are predisposed to Eclampsia, and permanent mental disturbance may follow.

Alcoholism associated with Lead poisoning in all forms of mental disturbance renders the prognosis much more grave.

The Renal Condition of a person suffering from Bright's Disease is sure to be aggravated and the person is exceedingly liable to develop Plumbism. Paralysis affecting the muscles of the lower limbs is of much more serious import than paralysis of the upper limbs. The former frequently becomes progressive and may eventually resemble Progressive Muscular Atrophy, with degeneration of the Spinal Cord.

Persons exposed to excessive doses of Lead absorbed through the Lungs may develop Mental Symptoms without any Prodromal stage. The prognosis here is exceedingly grave.

Speaking broadly, the prognosis of a case of Plumbism

occurring in industrial conditions is more favourable when Colic is a marked feature than when it is absent, and the prognosis of a case of Plumbism is much better now than it was before the introduction of general Medical Supervision and exhaust ventilation.

SUMMARY AND CONCLUSIONS.

Lead is a metal which is used to a very large extent in the various manufactures.

Its evil effects may be seen in persons who have taken water or other fluid containing Lead and in some cases those who have taken it as an abortifacient.

It is extremely wide-spread in its use.

As Lead Poisoning is one of the Scheduled Diseases under the Workmens' Compensation Act it has Legislative as well as a Clinical Interest.

It is a disease which work-people as a whole are not too prone to give all assistance necessary to Certifying Surgeons in the investigation, and in cases definitely try to mislead the Surgeon.

The examination takes place in a room at the works, and the majority of the workers are inclined to think that the Certifying Surgeon is on the side of the Employers, and will not recognise that the Certifying Surgeon is there to prevent Plumbism developing by recognising the Premonitory Signs.

In the Potteries, the best Glaze is that made from Lead. No satisfactory substitute for Lead Glaze which can compete with Foreign Wares, has yet been found.

Lead enters the system of the workers by several routes

the principal being:-

1. Respiratory Tract,

2. Gastro-Intestinal Tract.

In the former the Lead enters as Fumes or as Dust floating in the atmosphere, and in the latter the Lead may enter the system from the atmosphere but it is more liable to enter with food, or tobacco, which have been contaminated from soiled hands.

In my opinion, industrially, poisoning by Lead taken into the system by way of the Respiratory Tract is much more prevalent than poisoning by Lead taken into the system by way of the Gastro- intestinal tract.

Before workers were taught the dangers of taking food etc. with soiled hands, the incidence of Lead Poisoning was much more prevalent among Dippers and Takers off, than it is today.

Legge and Goadby have demonstrated by experiments that inhalation is the more dangerous.

I have made a survey of the Lead Workers in some of the Principal Factories in the Potteries e.g. Wedgewood's, Copeland's Green's and Minton's. In these factories the Dippers had been employed for a very much longer period than the Glost Placers, and as a whole the Dipper looked a very much healthier person than the Glost Placer.

The Principal symptoms of Plumbism are: -(1) Anaemia, (2) Blue Line, (3) Constipation, (4) Colic, (5) Paralysis, (6) Arterial Degeneration, and (7) Encephalopathy.

A Lead Worker may show distinct signs of Anaemia, Blue Line, and Constipation but they do not constitute Plumbism, legally, and a worker showing these signs would not be granted compensation. They merely show that some of the Toxic effects of Lead are present in this worker and constitute Lead Absorption. This worker may not be incapacitated from working, but may be transferred to other work by the Surgeon for some time to eliminate the poison, and afterwards he may return to work in a Lead Process.

The others, however, definitely constitute Lead Poisoning and prevent a worker from following his occupation or any other during the time of his illness.

When he recovers he should never be permitted to resume work which will bring him into contact with Lead in any form.

There is a marked sexual idiosyncrasy to Lead Poisoning. Females are much more prone to come under its influence then males, and pregnant women are very much more liable.

There also seems to be a family idiosyncrasy to the malicious effects of Lead. Members of the same family may quickly come under its influence.

Industrially, Lead Poisoning is the result of the continued absorption of minute quantitite of Lead salts which may take many years before definite evidence is seen.

It may, however, be the result of the taking of one large dose.

The previous condition is much more serious and far-reaching in its effects than the latter.

In the latter, the symptoms appear quickly, the patient seeks Medical Advice and may under treatment, permanently recover.

In the former, however, the poison has gradually been undermining the stability of the various tissues in a very slow but definite and progressive manner, and the patient may not be cognisant of any damage to the system until the effects on the tissues may be so great that cure is impossible and it may ultimately be the cause of death.

Great importance is attached to the effect of Lead on the Blood vessels and many of the symptoms and signs of Plumbism are referable to this. Lead causes degeneration of the blood vessels which allows minute haemorrhages to occur which are found Post Mortem in the organs showing the poisonous effects during life.

Lead Poisoning is a preventable disease and the great diminution is due to the instructions given to the workers and

to the precautionary measures which are enforced by regulations. Prevention may be summed up in the two statements.

1. Personal Cleanliness of the worker.

2. Absence of Lead in the atmosphere.

The responsibility is two-fold:-

1. On the worker,

2. On the employer.

The former must understand the dangers which his work involves, and the ways and means which are available to prevent his coming under the influence of Lead.

He should never commence work without having taken some food.

His hands etc. should be scrupulously clean before he leaves the factory or takes any food.

He should avoid raising any dust when at work.

Any defect in the preventive measures in the factory which come to his notice, he should report at once to some responsible person, as by this procedure he is not only preserving his own health, but the health of others.

The latter is responsible for minimising the dust raised in the workroom, by using Lead in the wet state as far as possible. If dust is raised it is his duty to provide means of withdrawing this dust e.g. by fans.

The employer must provide clean overalls for the workers and be responsible for the washing and renewal of these.

He must also provide suitable ablution rooms and suitable dining rooms.

The function of the Factory Surgeon is very important. He should examine all persons before commencing work in any Lead process and reject anyone suffering from Alcoholism, Renal Disease, Tuberculosis, Anaemia, and women who are pregnant or have a history of miscarriages.

He should prohibit any persons from working in a Lead process, who show signs of Lead Absorption, and have them transferred to some suitable employment where contact with Lead is impossible, and preferably to work in the open air.

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